The Electrical World.

VOL. XXXII. NEW YORK, SEPTEMBER 24, 1898. No. 13.

PUBLISHED EVERY SATURDAY BY

THE W. J. JOHNSTON COMPANY,

9 Murray Street, New York.

Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, 620 Atlantic Ave., Boston.
Western Office, 936 Monadnock Block, Chicago.
Philadelphia Office, 929 Chestnut Street.

SUBSCRIPTION IN ADVANCE, ONE YEAR, $3.00,

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THE PASSING OF THE WALKER COMPANY.

It is officially announced that the Westinghouse Electric & Manufacturing Company has purchased the stocks and bonds of the Walker Company, and will in consequence assume control of the entire business of the latter. The four former owners of the Walker Company—Messrs. Roswell P. Flower, J. W. Hinckley, Anthony N. Brady and Perry Belmont—it is stated take in part payment for their previous holdings an interest in the consolidated company, and will join the board of directors thereof. The Walker Company was bonded at $1,500,000, and was authorized to issue stock to the amount of $2,500,000. The recent sale of $3,000,000 5 per cent. bonds by the Westinghouse Company was in conjunction with this move.

By this change the Walker Company is brought under the terms of the agreement which for two and a half years has existed between the General Electric and Westinghouse Companies, and the fierce patent litigation that has lately been brought by the General Electric against the Walker Company is abruptly terminated. Owing to the connection of the owners of the Walker Company with many large users of electrical apparatus this company has recently been able to secure large contracts coveted by the General Electric and Westinghouse Companies, but the carrying out of these contracts has been seriously impeded by the numerous injunction suits instituted by the latter.

While there are those who deplore such a combination as this, and believe in aggressive competition between the different electrical companies, there are electrical engineers who think that, looking at the matter from the technical standpoint, the general effect of the coming together of these companies will be beneficial. One reason for this opinion is the peculiar patent situation. Where in many cases one of the companies had broad fundamental patents, preventing the others from manufacturing a certain style of apparatus, the others in turn, or one of them, had patents on detail improvements which in effect prevented the first from constructing a modern machine under the original patent, so that in some instances neither one of the companies could manufacture the most suitable apparatus, and each was obliged to resort to makeshifts to avoid the claims of the other. Now all three companies can pick and choose the best combinations of principles and details patented by the designers of any, giving, in many instances, more satisfactory and less expensive construction. The cost of manufacture can also be reduced by proper distribution and differentiation of the combined work between the establishments, while the cost of selling may be much lessened by the elimination of the considerable expenses attendant on competitive struggling for contracts.

There is in all industries where the danger of a monopoly appears a certain number of what may be called "sympathy" orders—orders given to a smaller company with the aim of maintaining competition. At one time the Westinghouse Company obtained these as against the General Electric Company. Of late they have gone to the Walker Company. For this reason, and because of the fact that all the larger companies are likely to remain crowded with work, the other smaller concerns in the field are not likely to be driven out by the combined companies, and may be benefited by the change. The rapid development of the electrical industries

makes it certain that, however advantageous it may seem to the stockholders to combine their issues with a view to the reduction of competitive struggling, such combinations are not the result of a falling off in business.

Fortunately in the electrical industries active competition is not essential for rapid development. The enormous fields for the applications of electrical methods, waiting only further improvement of the latter, such for example as suburban and interurban traction, and the active competition of non-electrical rivals, such as gas lighting, are sufficient stimuli and dangers to prevent any cessation of activity in electrical development, even were internal competition entirely removed.

A FASCINATING POSSIBILITY IN A NEW APPLICATION OF ELECTRICITY.

There may be found on another page extracts from the recent presidential address of Sir William Crookes before the British Association, describing the need for some means of "fixing" atmospheric nitrogen. According to this eminent authority, nitrogenous grain foods are coming into greater and greater consumption. The fixed nitrogen in the soil of grain-growing districts is rapidly being exhausted, cutting down the yield per acre, and available new districts for grain production are negligible compared with the increasing demand. The supplies of nitrates and other fertilizers are entirely inadequate. The fixed nitrogen consumed is thrown away in the sewage and drainage delivered to the ocean, the value of such fixed nitrogen being estimated at $80,000,000 per annum. The only hope pointed out is the development of some cheap method of fixation of atmospheric nitrogen. This can be done electrically by high-tension discharges, and figures are given to demonstrate that with extremely cheap power the product can be obtained at a cost comparable with that of fertilizers now used. The world's demand in the near future is estimated at 12,000,000 tons of nitrate of soda per annum.

TRACK RETURNS FOR RAILWAY CIRCUITS.

On other pages of this issue there may be found an interesting account of some novel track bonds in use on the system of the Brooklyn Heights Railroad Company. The peculiarities of these bonds are that they are brazed to the rails and the brazing is effected electrically. As they could not conveniently be brazed in place the bond is divided into two pieces, each half of which is brazed to the proper rail end in the yard, and when the rails are in place the two halves are riveted and soldered together. A valuable feature of these bonds is the fact that they are not, as are many bonds, longer than the tie plate, but make use of the steel of the rail for return current conduction up to within 2 or 3 inches of the rail end, thereby reducing greatly the amount of copper for the same bond resistance.

It is often argued that bonds should be of what is called the equivalent cross section of the rail—that is, the cross section of the bond should be to that of the rail as the resistance per unit volume of the material of the rail is to that of the bond. Just what reasons there are for this argument it is hard to say. The question of the cross section of bonds (outside of the contact section) is the same as that of the cross section of any electrical conductor, its determination being solely dependent on whether any increase in the copper would cost more in the long run than the saving effected, or vice versa. Further consideration shows that the cross section of the bond should be practically the same as that of the conductor which would be used to carry the same current to the station were the steel in the track not utilized for that purpose. This is due to the fact that the short sections of the track return, consisting of bonds, cost as much per foot of length as would a bare return conductor of the same section, and the drop within them is the same per foot of length. The size of long bonds is therefore determinable by the same rule which would be followed in fixing the size of a return feeder, the proper cross section of short bonds being influenced perhaps to a certain extent by that necessary for contact with the rail and structural considerations. The bonds might in certain cases be of more than equivalent cross section of the rails and in any case should increase in size on approaching the power house, or, in other words, be proportioned to the current flowing.

As the rails themselves serve another purpose beside that of supporting the cars, the determination of their cross section becomes influenced thereby. The use of a light rail and a return feeder is in the present state of the art a great mistake. The return copper costs as much or more than the equivalent increase in rail section and by putting the same investment in the latter the resultant mechanical improvement in the roadbed is practically obtained for nothing. Where return currents are extremely heavy, as in the neighborhood of power houses of large systems, rail sections of weights much greater than those now used would be advisable, were such rail sections obtainable without extra expense for their rolling. A 200-pound per yard rail, if it could be obtained at the same cost per ton as a 100-pound rail, would be much more satisfactory when properly bonded up than the 100-pound rail, if with the latter a return feeder costing as much as the extra hundred pounds were necessary.

THERMOPILE ICEBERG ALARMS.

Some of our contemporaries have contained accounts of an iceberg alarm, intended to be mounted on shipboard and to announce the neighborhood of icebergs in a fog, consisting of a thermopile mounted on a revolving vertical axis and furnished with reflectors, etc. The ingenious idea underlying this instrument is that the thermopile is constantly exchanging radiations with its surroundings, and that when confronted with an iceberg the sudden outrush of radiant energy from the front of the instrument to the relatively colder ice causes a current to flow and thus advertises the presence of the invisible berg. All this is very interesting, but a practical difficulty in the way of the instrument is that water vapor and fog are absolutely opaque to radiant energy of low-wave length. Even the enormous energy of the sun is unable to send long waves through an invisible cloud of water vapor in the upper air. One of the most curious and unexpected results of the recent research upon solar radiation at the Smithsonian Institute was the existence of vapor clouds, transparent to ordinary light and entirely invisible, which completely cut off the radiant energy of the sun below certain wave-lengths. A fog at sea is, consequently, as opaque to the radiant energy originating at the front of a thermopile as to visible light.

Patents in Central and South America.

In Bolivia patents are granted for three, six and ten years, and the patents must be worked within one year from the date of granting. To guarantee this working there must be given a deposit when the patent is granted of 100 or 200 or 300 bolivianos, according to whether the patent is granted for three, six or ten years.

In Colombia the patents are granted for five, ten, fifteen or twenty years, with no annuities and no requirements of working.

In Costa Rica patents of non-residents have the same term as the original patent, with a maximum of twenty years. There are no annuities to pay, but the invention must be worked within two years.

In Ecuador, Honduras, Nicaragua and San Salvador there are no established patent offices, but the Government grants rights by special legislation in each case.

In Peru patents are granted for ten years, with no annuities, and the requirement of working is generally within two years.

In Uruguay patents are granted for three, six or nine years, with an annuity equivalent to about $26, and the requirement of working is generally within two years.

Track Bonding in Brooklyn.*

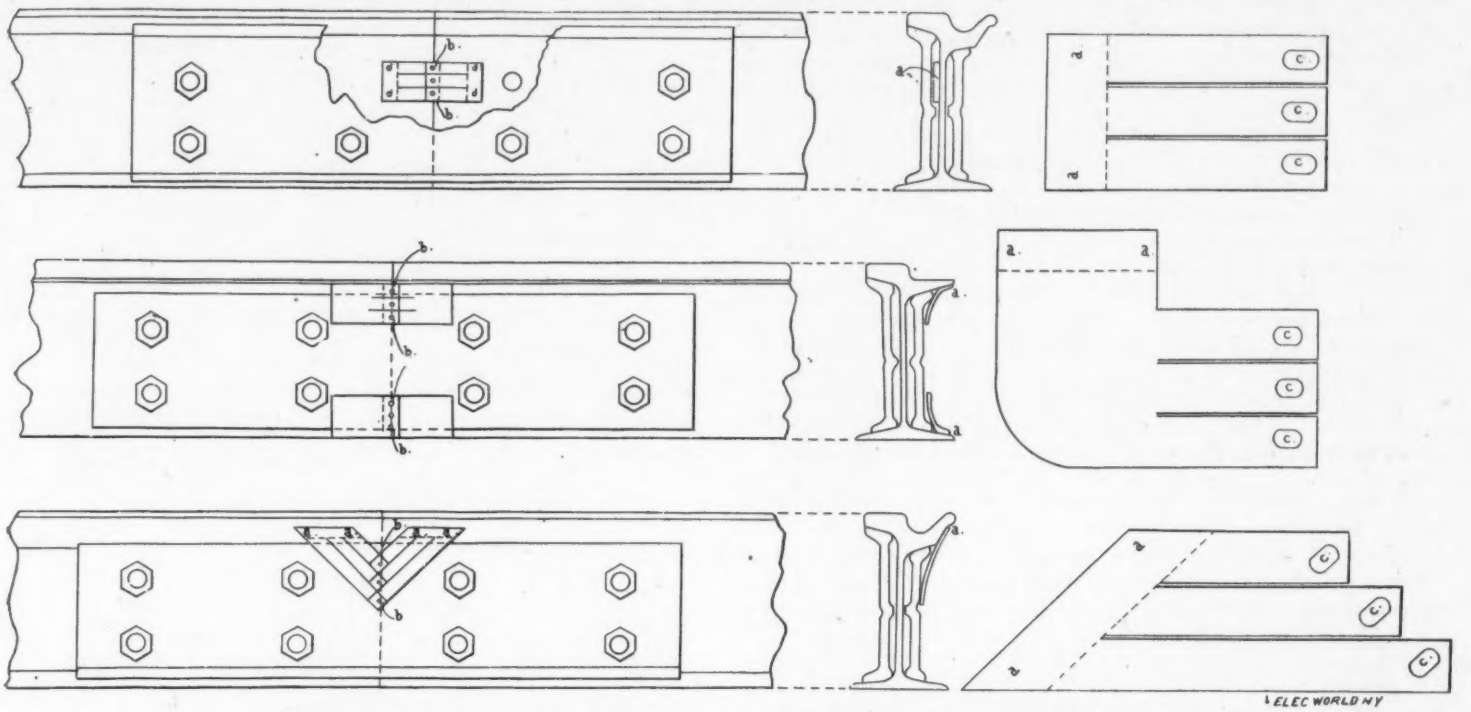
The tracks of the Brooklyn Heights Railroad system were originally bonded with the familiar supplementary wires, the section of the rail being such that it was difficult to use any other method. This wire, as well as the branches leading to the rails, was tinned so as to make good contact with the earth, and large copper plates, also tinned, were placed in the damp soil or water in the vicinity of the power house. These plates soon became corroded and coated with insulating substances, and were practically of no value in collecting the ground current, so return feeder wires were run out to make frequent taps to the supplementary wire. As the traffic of the road increased, the cost of this return copper became a serious matter, and when it became necessary to relay the tracks in 1895 the question of bonding received careful consideration. The rails were practically carrying no current, and it was decided that the new construction of 9-inch girder rails would increase considerably the conductivity of the return circuit, provided they were properly bonded.

To take full advantage of the large amount of metal for the track, a bond of high conductivity, the shortest possible length, and low contact resistance was required. At that time no bond meeting all those conditions could be found, and one was designed by the engineers of the company. As the joints were suspended, there was sufficient space between the ties for inserting bonds underneath the base of the rail, and arrangements were accordingly made to make contacts at that point. The bond decided upon was of cast copper, the full width of the base of the rail, and the connection between bond and rail was obtained by surface contact, about twelve square inches of surface being covered by the bond on the end of each rail. This contact came within three-quarters of an inch of the end of the rail and the connecting metal was left the same size, five inches wide and one-sixth of an inch in thickness, the bond being a trifle thicker at the point of contact. The connecting piece of metal was curved so as to allow for expansion. To secure good connection a reinforcing plate of cast iron was placed underneath the area of contact and the bond pressed firmly against the rail by two and one-half-inch bolts passing through the base of the rail. No machine work is done on those bonds other than girdling the contact face. The scale was removed from the rail where the bond was to be applied by grinding with a portable emery wheel. This was not a very costly operation, as the rails were arranged with bases uppermost as they were unloaded from the lighter and no rehandling was necessary.

*The report of the Committee on Track Bonding, Messrs. R. P. Brown and G. E. Chapin, electrical engineers of the Brooklyn Heights Railroad Company, Brooklyn, presented to the New York State Street Railway Association, Manhattan Beach, September, 1898.

To prevent corrosion a shallow groove was formed around the contact space and an attempt made to seal the bond watertight by forcing into this groove a non-hardening pitch, heated until very fluid. Owing to the fact that the groove was necessarily very shallow, the bond plate being only three-sixteenths of an inch thick, this sealing was unsuccessful in practice; but owing to the large area of contact, if rust has formed in the joint, it has in no way affected the conductivity, as recent tests show these bonds to be practically of the same resistance as when first installed, three years ago.

The cost of these bonds was not greater than that of the oooo bond going completely around the fish-plate, and having two or three times the electrical resistance of this connection. The difficulty of attaching a bond underneath the base of the rail, however, was considerable, and careful supervision was necessary to have the work performed in a proper manner. This trouble led to further investigations, with the result that a bond electrically brazed to the rail was adopted the following year. This bond was somewhat cheaper than the plate bond and good work was more easily obtained on account of the better chance of inspection. The use of such a bond had been discussed the two previous years, but was not developed on account of a doubt whether the contact could be made large enough to prevent heating when considerable current was flowing, that might give rise to thermo-electric effects between the copper and the iron.



VIEWS OF RAIL JOINTS WITH BRAZED BONDS, AND ENLARGED VIEWS OF THE LATTER.

A sample of copper brazed to steel was secured, and after careful tests it was found that the contact between copper and steel was of negligible resistance, as compared with the resistance of the copper strip. Owing to patent difficulties it was impossible to make any arrangements with the firm supplying this sample for the use of the bond that year, but a series of experiments demonstrated the possibility of electrical brazing by a process developed by the electricians of the company. There was not sufficient time to obtain special apparatus for doing this work, so the electrical current needed was taken from the railway circuit. To obtain the low voltage required the brazing apparatus was connected in series with a generator between the circuit breaker and the negative bus of the station. The voltage of this dynamo was raised high enough to overcome the added resistance, and the generator run in multiple with the others in the power house. Several brazing contacts were in series so that the resistance could be kept as uniform as possible, and owing to the large output of the stations the variations in the load were slight and no trouble ensued in the regulation of the dynamos used in the welding circuit. Transformers have since been obtained for doing this work, and the brazed bond has been adopted as the standard on all the heavy lines of the system. As no portable brazing apparatus had been obtained the bonds

are made in two parts and brazed on the rail ends before they are removed from the yard.

The shape of the bond depends on whether it is placed on the web of the rail, so as to come underneath the fish-plate, or, as it is now applied, on the base and upper flange of the rail, outside of the joint plate. All forms of the bond, however, are made up of ten and twelve leaves of one-sixty-fourth soft copper, the carrying portion of the bond being one and three-quarters inches wide, and the brazed contact having an area of about one square inch. Soft spelter, with suitable flux, is used in brazing the copper to the steel rail. The bond is divided longitudinally into three parts, so as to give greater flexibility. When the rails are in position the ends of these bond leaves are interlaced and fastened together by rivets and also by solder. The length of the bond between centre of contacts is five inches, and its cross-section is equal to 350,000 circular mils.

All the brazing of the several thousand bonds now installed has been done with a makeshift device, employing processes developed entirely by the electricians of the company. License under the patents of General Payne, of Elmira, and the Thomson Welding Company has been obtained, to guard against any claim of infringement.

On account of the great number of miles of track that are rapidly being relaid it was found to be impossible to braze bonds for all the rails with the inadequate means at hand, so the lighter lines have been bonded with the short bonds of the "horseshoe" type placed underneath the fish-plates. The holes for these bonds are drilled by the makers of the rail, and they are reamed out with emery paper to remove the rust that may have formed during shipment. If care is used in compressing the terminal of those bonds there is no necessity for drilling or reaming of holes on the ground, as any slight irregularity in the drilling fills up when the soft copper is thoroughly upset. The horse shoe bonds are three and one-quarter inches in length of 0000 cross-section, and have three-quarter-inch diameter terminals. As a measure of safety, as well as to lower the resistance of the joints, all rails are double-bonded, whether the brazed or horseshoe bonds are used.

Curved rail, switches, and other special work are often difficult to bond satisfactorily in the yard, and the joint plates are of such section that the bond cannot be placed underneath. In such work long bonds going round the fish-plates are used. On account of the excessive wear on special work the joints are particularly liable to loosen, so that the bond must be extremely flexible. The 0000 bonds are used on this work, and to keep the conductivity the same as the street rail both sides of the special work are cross bonded, and the circuit reinforced by running 500,000 c. m. wires joining these cross connections, the number of wires used depending on the current density of the track in each section. The straight track is cross-connected every 750 feet. Those cross-connections are made of 500,000 c. m. wire, fastened to the rail with a terminal for the contact similar to that of the plate bond mentioned before. These terminals have about six square inches of contact and are soldered to the rail. The terminals have a cast iron reinforcement and are bolted to the web of the rail, so that no mechanical strain can come on the soldered joints. This same terminal is used to connect the return wires in the track adjacent to the power house to the negative bus.

It has been found that if a single bond is used it should be placed at the centre of the web of the rail if sufficient contact can be obtained at that point. If contact is made at either the base or upper flange the length of the circuit is increased by the height of the rail, and in case of the nine-inch girder the increased resistance is equal to a half of the total resistance of the bond itself. On account of the greater depth of metal, it would seem advisable, when two bonds are used, to apply one on the top of the upper flange of the rail and the other on the base. Solid joints are very apt to break if the joint plates become loosened to any extent, and are consequently never used on special work. Contrary to the former practice of tinning the bonds and supplementary wire, the bonds and their exposed copper surfaces are carefully coated with an insulating paint, so that if there is any flow of the current of the track to the surrounding soil it must leave from the steel and not from the copper. This prevents the bonds being destroyed by electrolysis or other corrosive action.

The Falk cast welded joints make the best possible electrical connection, and if care is used in the installation, conductivity almost equal to the continuous rail can be obtained. The new electrically welded rail joint, made by the Johnson Electric Company, promises to be equally good.

To guard against imperfect workmanship a system of testing bonds has been practiced. Usually only the joints on one line of rail are tested, though in sections of high-current density, as in the vicinity of power-houses, the resistance of each joint is obtained. The test is a simple comparison of the fall of potential across the joint and on a measured portion of an unbroken rail. Two Weston millivolt meters, with scales ranging from 0.001 to 0.3 of a volt, are used; the readings being taken simultaneously. Contact is obtained by pressing hardened steel points on the surface of the rails. These points are set in wooden blocks and placed six inches apart if used on the joints, and two feet apart for tests on solid rail. The distance on the rail is taken for two feet instead of one foot, on account of the small amount of current flow in the rail on some of the lighter lines. These testing terminals are provided with handles of convenient length so that the person using them can stand upright and apply the necessary pressure with one foot. Two men can test joints very rapidly with this outfit. The current density of some of the rails was too low to give reliable readings with these instruments, so a portable resistance was arranged on a wagon and the necessary current readily obtained from the trolley wire. This resistance allowed about 300 amperes to flow from the line to the rail, and as it could be very quickly applied rendered it a comparatively easy matter to test the joints in any section of the city.

Although the bonds are less than six inches long, that length was selected for the distance between terminals of the voltmeter used in testing joints, because it gives a convenient fraction to subtract from the length of each rail in arriving at the total resistance in line of track. The drop on this six inches was considered as increasing the length of the rail by an amount proportionate to the drop in the rail itself. From this the percentage that the rail of any line approached the conductivity of the solid steel rail could be easily determined.

The following results were obtained from different joints:

FALK JOINT.

Drop.			% of Conductivity.
1 foot of rail — 1 foot of joint			
.00215	.00355	(30 foot rail)	98
		(60 foot rail)	99

DOUBLE BRAZED BOND.

1 foot of rail — 1 foot of joint			
.00725	.00758	(30 foot rail)	99.8
		(60 foot rail)	99.9

JOHNSON BOND.

2 feet of rail — 6 inches of joint			
.00364	.00342	(30 foot rail)	95.6
		(60 foot rail)	97.8

PLATE BOND.

2 feet of rail — 6 inches of joint			
.0109	.0233	(30 foot rail)	89
		(60 foot rail)	94

It will be seen by the foregoing that it is a comparatively easy matter to get a conductivity of over 90 per cent of a continuous steel rail. As high as 600 amperes can be safely carried on any of the bonds mentioned, and the cost of double bonding in a satisfactory manner should not exceed 75 cents per joint. The conductivity of steel varies with the amount of carbon in its composition, but, generally speaking, it is about one-eighth of the conductivity of commercial copper. Bearing these facts in mind, it will be readily seen that it is much cheaper to make the return circuit wholly of well-bonded steel rails, supplementing the track in the vicinity of the power houses with worn-out rails carefully bonded.

The Peacock Feather for Inventors.

A consular report from Pekin states that an imperial decree calling for the establishment of a patent and copyright system has been promulgated by the Chinese Government. The rewards of genius are widely different from those customary in other lands. For example the decree states that "if it be found that such geniuses have real ability to become officials we will appoint them to posts as a reward, or grant them decorations or fine raiment in order to show the masses the persons who have gained honor by their talents and genius."

The Cost at the Switchboard of Electric Power for Street Railways.*

BY R. W. CONANT.

It is my privilege to be able to communicate to you facts and figures bearing on the operation of forty-four power stations located at the important street-railway centres throughout the country.

These figures cover for the most part the operation of the stations during the past year, and were obtained through the kindness of members of this association as well as from experience on the roads in Boston.

The aggregate capacity of power stations represented is 98,387 kilowatts or 131,800 electrical horse-power.

The total cost of operation for the production of power alone from these stations during the past year has been $1,825,000 and *if* the power had been produced by all at as low a cost as it was in a number of the more economical stations the saving for the year would have amounted to $443,300.

It is the chief purpose of this paper to explain the *if* and to obtain some idea of its size.

In what has been published on this subject there are a great variety of opinions as to what should be included in the cost of power and also as to whether the basis of comparison should be the car-mile or kw hour, this latter being due to the fact that up to within a few years there has been no reliable instrument adopted by street railways for the measuring of their output.

The car-mile basis is not a fixed standard. A car-mile up hill takes a great deal of power, while a car-mile down hill should take none and may be made a source of power.

In the analysis of costs of operation of power stations of various sizes and types, it is first necessary to adopt a standard for the unit of power. We have seen that the car-mile is unreliable. Recording wattmeters are at present constructed which will measure the output in kw hours. They can be made to give results which are accurate within a very few per cent. This statement is abundantly verified by actual experience and is gradually becoming universally recognized. It is no doubt difficult for one who has been accustomed to figure cost of power production on a car-mile basis to reconcile himself to the kw hour. It should, however, be very easy for the steam engineer who is accustomed to deal with horse-power, since the kw hour equals 1.34 electrical hp hours.

It was evidently the idea of your executive committee in limiting the title of this paper to cost at the switchboard to abolish the car-mile and adopt the kw hour as the unit of power. And in comparing the costs from the various stations I shall use this unit. For the benefit of those who are accustomed to considering the cost per car-mile, it will be interesting to know that on many roads a car-mile takes just about 1 kw hour. This is not true where grades and equipments are extremely heavy; in such cases two or three times this amount may be required.

In the costs of power, whether it is produced by steam or water, should be included the fixed charges as well as the cost of operation. Under fixed charges are interest, depreciation, insurance and taxes on the capital invested in the land, buildings and machinery of the power station.

Under operating expenses are fuel, labor, supplies, repairs, superintendence and general expense.

In both the fixed charges and operating expenses the component items vary between widely different limits, and it becomes impossible to construct a law that will predict the cost under all circumstances.

On the other hand, for one who has had experience it is comparatively easy to predict what the power ought to cost under a given set of conditions. What it will cost must, of course, depend on management as well.

In view of the variety of the circumstances gverning these costs I have deemed it advisable to establish, for purposes of comparison, a standard plant whose conditions are fixed.

It is not my intention to imply that the performance or equipment of this station, which I shall employ as a standard, is ideal or could not be bettered, but rather to assume equipment and performance based on facts obtained from stations in actual commercial operation during a long period of time.

As this station is described, its performance may seem to border on the ideal, and there is no question but that its performance is consequent on favorable circumstances, very nearly we may say test conditions. It is, however, in my opinion best to err on this side rather than on the other in establishing a station for comparison.

I shall assume the station to be located on the water front; the exact spot is unimportant, but since this association has chosen Boston as its meeting place we can consistently locate the station here as well. I have fixed the capacity at 3600 kilowatts. The building erected on firm ground requiring but little piling or filling, building and chimney of brick.

For equipment three cross-compound condensing engines, cylinders 28 inch and 56 inch by 5 foot stroke, speed 80 revolutions per minute, 150 pounds steam pressure; three 1200-kw direct-connected generators; six water-tube safety boilers, 500 horse-power each; economizers and exhaust feed-water heaters; electrically driven feed pumps and coal-handling apparatus. Such a station would cost to install as follows:

CAPITAL INVESTMENT.

Building, foundations for engines and boilers, chimney, coal-handling apparatus	$120,000
Engines and condensers, heaters, separators and piping	91,800
Feed pumps and economizers	18,000
Boilers and flue connections complete	61,000
Generators and switchboard complete	73,800
Land and docking facilities	17,000
Engineering and sundries	5,000
Total	$386,600

or about $107 per kw capacity.

To obtain the figure for fixed charges, I assume interest at 6 per cent., insurance and taxes 3 per cent., depreciation 2 per cent., total, 11 per cent., which makes an annual fixed charge of $42,520.

I shall assume that this station produces 10,500,000 kw hours per annum. Dividing the annuall charge by this figure gives 0.4 cent per kw hour for the fixed charges. The depreciation is not intended to cover repairs, which will be included under operating expenses. The 2 per cent. assumed for depreciation is to establish a sinking fund against the time when the station will have to be entirely replaced by one of more modern and economical design, time of replacement being taken at fifty years. A few years ago the time of replacement should have been assumed much shorter, owing to the imperfect design of power station apparatus then existing. But with the present advanced state of the art improvements cannot be expected to develop as rapidly.

Before arriving at the cost to produce power from this station, it will be necessary to obtain the operating expenses.

In making comparisons between stations of different sizes and types the cost of labor is the most perplexing item, some stations operating with two shifts, others three. Some have engineers paid at different rates, and men that appear on the records of some are in a capacity which in others is absent or replaced by men of another class and rate of pay. I therefore give the following method of analysis of the labor item, which gives satisfactory results when applied to station operation.

I can illustrate the method and at the same time derive the operating expenses by applying it to our standard station. It is assumed that this station operates with three shifts of men, the duration of each shift being eight hours. This makes the shift hours per day 24, or 8760 for the year. The same number of shift hours would, of course, be obtained by two shifts of twelve hours each, as is the case with some stations. For the three-shift station the first two probably would have the full complement of men, while the third would not, as the station might be shut down on that shift. But as there is considerable inspection, cleaning and overhauling, this shift requires almost as many men, though their rate of pay may be less. The highest rates of pay would be on the shift of heaviest load. The crew to operate the standard plant would be about as follows: two engineers, one oiler, one helper, two firemen, one coal passer; total, seven men per shift.

The average rate of pay per man is taken at 27 cents per hour. This would be calculated from an actual station by dividing the total amount paid for wages, including chief engineer's salary, by the product of the number of men operating with the hours each has worked. The number of men per shift for this station being seven, I will divide this figure by 3.6, which is the figure expressing the capacity in 1000-kw units. This division gives 1.94 as the number of men per shift per 1000-kw capacity. This figure will

*Paper read before the American Street Railway Association, Boston, September, 1898.

vary with the type and size of station, as we shall see later. The fractional part of the man, of course, only appears in figuring.

Multiplying the 1.94 by the rate of pay, 27 cents, gives 52 cents as the cost of labor per hour per 1000-kw capacity. This multiplied by 3.6, the number of 1000-kw capacity, gives $1.87 as the total cost of labor required to operate the station per hour.

It will further aid in the analysis of the labor item to introduce the load factor. As this term is sometimes employed in a different sense from that used in this paper, I shall define it to be that per cent. which when multiplied by the capacity of the station in kilowatts and by the shift hours for the period gives the kw-hours output for the time considered. I take as the load factor for this station 33.3 per cent. average for the year. You may remember that in the consideration of the fixed charges I gave as the kw hours per year 10,500,000, which is 33.3 per cent. of 3600 kilowatts, multiplied by 8760, the shift hours per annum.

It has been shown above that $1.87 is the average cost of labor to operate the station for one hour, and if we obtain the average kilowatts during the hour, which is kw hours for that period, a simple division will give the figure for the cost of labor per kw-hour.

The load factor gives the means of obtaining the kw hours, and by multiplying 3.6 by 1000 and 33.3 per cent. gives 1200 as the average kilowatts for the hour, or kw hours for that period. Dividing $1.87, cost of labor to operate the station per hour, by 1200 gives 0.157 cent as the cost of labor per kw hour. But 3.6, the figure representing the capacity, was used as a multiplier in obtaining both the cost of labor, $1.87, and 1200 kw hours. It therefore disappears in the division and the expression for the cost of labor per kw hour is made independent of the capacity of the station to that extent. The rule, then, for obtaining the cost of labor per kw hour for any station is to multiply the rate of pay of the men by the number of men per 1000 kw capacity, and divide by the product of the load factor and 1000.

The use of this method will be illustrated if we compare the cost of labor per kw hour in the first two columns of table No. 1. It is 0.157 for the standard and 0.56 cent for station No. 1. It is rather difficult to account for this great increase until we notice that the number of men per 1000 kilowatts is 4.7 as against 1.94. The rate of pay and load factor also enter, as I shall show later.

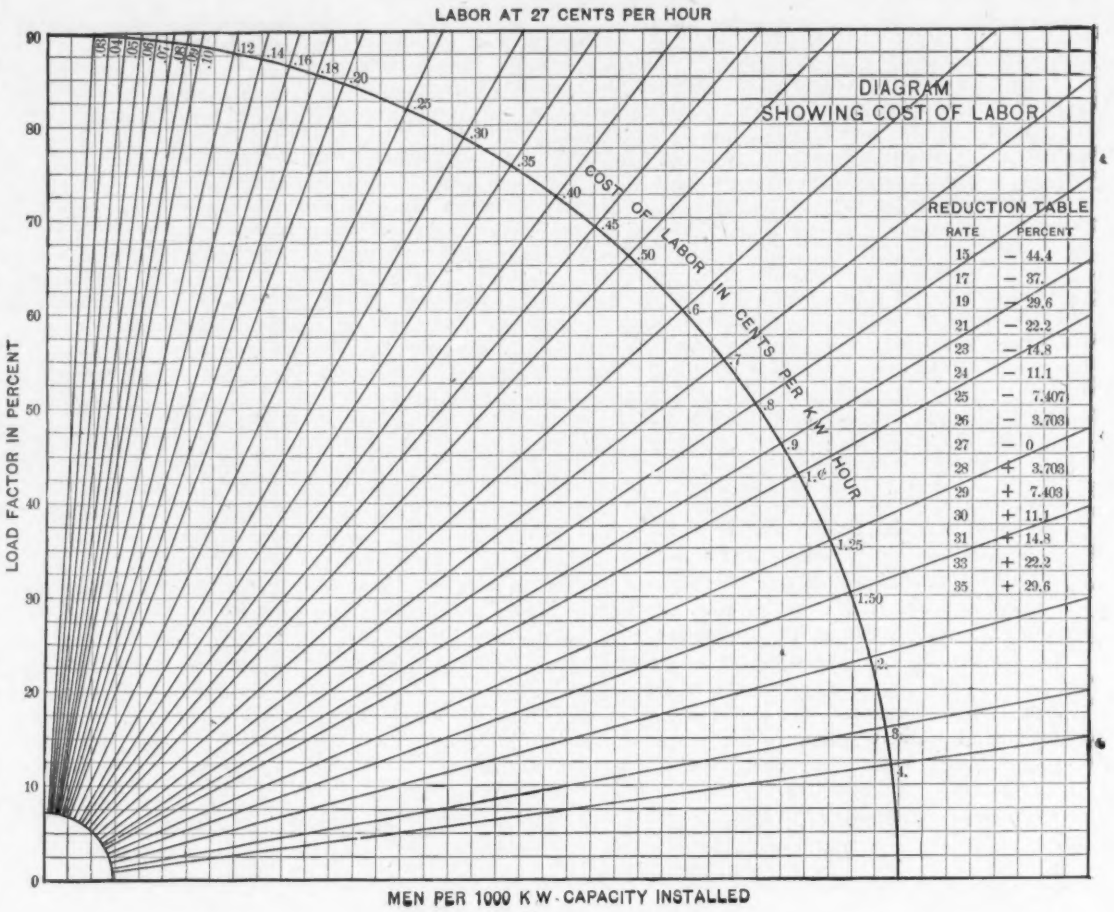


FIG. 1.

I have constructed a diagram which gives the results of this expression for cost of labor for all usual rates of pay, load factors and men per 1000 kilowatts. This diagram (see Fig. 1) is based on a rate of 27 cents per hour, and there is also given a reduction table which gives the per cent. to be added or subtracted for other rates than this. To illustrate its use suppose we have a station whose equipment requires five men per shift per 1000-kw capacity. During a month of high output it might operate at a 30 per cent. load factor. On the diagram following 5 up to 30 gives cost of labor at 0.45 cent per kw hour. In a lighter month the station might operate at a 15 per cent. load factor. Following 5 up to 15 gives 0.9 cent, or twice as much for labor per kw hour.

To further illustrate the use of this diagram let us consider that the equipment of our standard station is cut into so many units that it required 3.7 men instead of 1.94, price of labor and load factor being 27 cents and 33.3 per cent. respectively; 3.7 followed on the diagram up to 33.3 per cent. gives 0.3 of a cent as against 0.157 cents for standard.

The cost of fuel is the next item to be considered in the operating expenses of the standard station. Considering coal as the fuel used its cost per kw hour depends on the price per ton and on the efficiency of the station, which is best expressed in pounds coal consumption per kw hour. The coal for standard station I have assumed to be clear bituminous, costing $3 per short ton delivered.

As to the efficiency, I am able to quote from tests in which I was personally engaged on a station of the same size and similar equipment. The duration of the test was forty-five hours, made under actual conditions of railroad service during the day, and at night the load was kept on the station by means of a water rheostat. I will say here, however, that the test on the steady night load did not show any great gain in efficiency due to the fact that the day load of the station was steadied by feeding in with others. The average efficiency of transformation, indicated horse-power to electrical horse-power at the switchboard, was 90 per cent. The steam consumption of the engines was 14.5 pounds per indicated hp-hour. This record on a later test has been lowered. The boiler evaporation was 9.4 pounds water per pound of coal from actual conditions. The coal used was New River bituminous. The economy of the station, represented by the coal consumption in pounds per kw hour, was 2.3. I have assumed 2.2 for this figure for the standard station.

Reducing price per ton to price per pound and multiplying by 2.2 gives 0.33 cent as the cost of coal per kw hour. This appears in table No. 1 under cost of fuel. As an illustration of what the cost would have been had the engines required more steam, say 26.6 pounds per indicated hp hour, as might be the case with a non-condensing engine: Referring to the fuel diagram and considering the electrical efficiency, boiler evaporation and price of coal to remain the same, 26.6 to 9.4 pounds water per pound of coal gives 3.8 pounds coal per kw hour. Following this line down to horizontal $3 coal line and vertically upward from this point to cost of fuel in cents per kw hour we obtain 0.57 cent, were the efficiency of transformation 100 per cent., but since it is assumed to be but 90 per cent., 11 per cent. has to be added to this cost, as shown in the reduction table. This gives the cost of coal per kw hour 0.63 cent as against 0.33 for the condensing engine.

There remain to be included in the operating expenses for this

station, water, oil, small supplies, repairs, superintendence and general expense, which I have estimated at 0.093 cent per kw hour. The total operating expense foots up to 0.58 cent, which, added to the fixed charge of 0.4 cent, makes the total cost of power from the standard 0.98 cent, or very nearly 1 cent per kw hour.

Before comparing the costs from the various steam plants I will review briefly the circumstances governing the production of power by water.

The application of water power to street railways has the following points of advantage. In plants operated under any but very low heads the generating machinery may be installed at a less cost than for steam. Also the fuel expense disappears as well as a portion of the cost of repairs. A part of the labor expense will be saved, inasmuch as no engineers, firemen or coal handlers are required.

The main disadvantage in the application of water power to street-railway operation lies in the fact that generally railroad power stations are quite distant from water falls, and that it is very expensive to transmit the electrical energy to any considerable distance, the distance of transmission being hundreds of miles

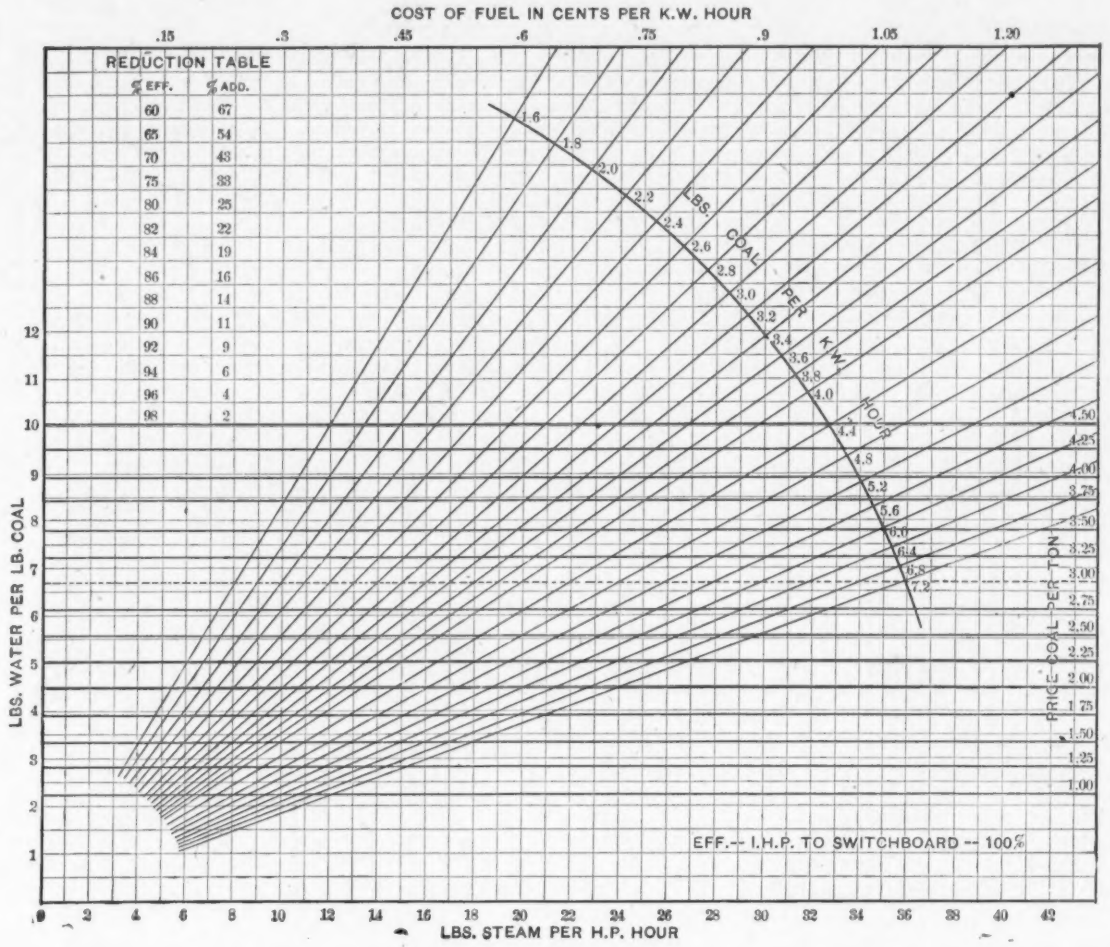


FIG. 2.

for the majority of street railways. That it may be made more profitable to employ water power when its location is near by the road and the price of coal is high also there can be no doubt.

The cost to produce power from water is often compared with the cost to produce from coal on the basis of continuous operation for twenty-four hours a day. For street-railway service this method gives a false impression, since it implies that the machinery is working at its full capacity for 8760 hours per annum, or 100 per cent. load factor; as a matter of fact for street-railroad service a load factor of 33 per cent. is high.

To look at this from another point of view; the demand for power for street railways cannot be increased at will as it may be in a manufacturing concern. In the latter if it is found advisable to run night and day at full capacity, instead of ten hours, there is produced a correspondingly greater amount of the product, be it flour, steel rails or carbide of calcium, and this output is produced at a correspondingly decreased cost per unit.

For street-railway service on the other hand there has to be installed sufficient generating machinery to take the peak of the load. This is usually three times the average and is only of a few hours' duration each day. If it were necessary or profitable to use this full capacity continuously for other industries, it would be possible to do this with very little increase of labor, no increase of fixed charges and the additional expense of producing the greater output would be merely the coal and a slight increase of supplies and repairs. This combination is the feature of the Niagara work.

When the expense of transmission shall have been decreased by the successful employment of higher voltage, it will then become a problem as to whether it will not be profitable to produce power from a steam plant located at a coal mine, coal costing in this case but 80 cents a ton. This would bring the cost of fuel to 0.12 cent per kw hour as against 0.3 cent for standard plant. Further, this expense would only continue for the comparatively small number of hours that the plant would have to be operated for street-railway service. This might be better economy than to pay the fixed charges that would accrue from the expensive development of water powers at possibly much greater distances.

It is to be noticed in this connection that the cost of installing the steam station would be considerably less when located at the coal mine, since it would then be unnecessary to equip with the most economical and expensive machines.

Water power produced in various parts of the country varies greatly in its cost. It is reported that the electrical energy so produced costs from $14 to $32 per annum per kilowatt continuous output. This expense is largely made up of fixed charges, which increase rapidly as the expense of making the necessary improvements is greater. The standard steam plant produces power with $3 coal for $29, and with 80-cent coal for $22 per kilowatt per annum, which compare very favorably with the above for water power.

A disadvantage occurring in the use of water power is that in some cases, on account of certain periods of low water, an auxiliary steam plant has to be kept in reserve, which is, of course, an additional expense.

There can be no general rule given that will determine whether it is more advantageous to use water or steam power. Each case must be figured by a competent engineer, and decided on its merits.

The great majority of street railways being operated by steam, I shall not dwell longer on water power, as there is still considerable ground to be covered in the consideration of the steam stations.

I have compiled and classified the data on representative ones throughout the country—tables Nos. 1 and 2 give the results.

The general arrangement of the tables is as follows: Each vertical column contains the data for a different station during a stated period. Each station is represented by a number which appears at the head of the column. Only a portion of the table is exhibited to you on the large diagram, for obvious reasons, but I will describe the different items as they appear in the completed table. The first column is headed S. for standard station; following down the column first comes the capacity expressed in multiples of 1000 kilowatts, 3.6 meaning 3600 kilowatts.

The number of units of engines is 3, ditto for generators, 3; number of engine units per 1000-kw capacity is 0.83, obtained by dividing 3 by 3.6, ditto for generators, 0.83. The next line under Type is a description as to whether the engines are belted or direct connected to the generators—B. for the former and D. C. for the latter. The two lines marked S. C. T. and N. or C. refer to en-

gines simple, compound or triple, non-condensing or condensing, as in standard C is compound condensing.

The period during which the averages are taken is given in days. Load factor is in per cent. Inserted in the proper place under costs are the per cent. S. and per cent. total, which figures represent the per cents. the items bear to the corresponding ones for standard, and to the total operating expense respectively.

The number of shifts, duration in hours and shift hours, together with the rate of pay of men in cents per hour, and number of men per shift per 1000-kw capacity, complete the data necessary for the analysis of the cost of labor. Costs are all expressed in cents per kw hour. Opposite Fuel, pounds of coal per kw hour and price, which is in dollars per short ton, give the necessary figures to analyze the cost of fuel per kw hour. Kind A. or B. refers to anthracite or bituminous.

Repairs, supplies other than coal—that is, water, oil, waste, lamps and miscellaneous, as well as superintendence and general expenses ——are treated as one item hereafter called general expense.

As a supplement to the tables, in order to more clearly illustrate we might expect them to hold approximately for stations under similar governing conditions.

I shall next call to your attention station No. 3, whose equipment differs from the standard as follows: It has two units instead of three. Each generator is 800 kilowatts, making a capacity of about half that of the standard. The generators and engines are direct connected, the latter being compound condensing, smaller, of course, than the standard, but in other respects similar. Three 500-hp water-tube boilers, economizers and heaters complete the important part of its equipment.

Group No. 3 indicates the cost of power for this station. At the extreme left is standard, the next column showing costs per kw hour averaged for one year. At the extreme right of the group is the average for a light month and at the left of this is the month of high output. It is to be noticed that the total cost of operation for the year is somewhat greater than standard. Coal expense practically the same. Labor and general expense somewhat higher. Coal expense being the same does not in this instance indicate that the economy of the station is as good, as, by referring to the table,

TABLE No. 1.—SHOWING COST OF OPERATION OF POWER STATIONS.

	No. of Station.	S.	1	2	3	4	5	6	S.	1	2	3	4	5	6	S.	1	2	3	4	5	6
Cap. in 1,000 k w		3.6	.6	2	1.6	12.68	2.38	.744	3.6	.6	2	1.6	12.68	2.38	.744	3.6	.6	2	1.6	12.68	2.38	.744
Type.	Units E	3	3	2	2	8	2	4	3	3	2	2	8	2	4	3	3	2	2	8	2	4
	Units G	3	3	2	2	8	7	12	3	3	2	2	8	7	12	3	3	2	2	8	7	12
	Units E per 1000 k w.	.83	5	1	1.25	.63	.84	5.4	.83	5	1	1.25	.63	.84	5.4	.83	5	1	1.25	.63	.84	5.4
	Units G per 1000 k w.	.83	5	1	1.25	.63	2.94	16.2	.83	5	1	1.25	.63	2.94	16.2	.83	5	1	1.25	.63	2.94	16.2
	B. D. C.	D C.	D.C.	D.C.	D.C.	D.C.	B.	B.	D.C.	D.C.	D.C.	D C.	D.C	B.	B.	D.C.	D.C.	D C.	D.C.	D.C.	B.	B.
	S. C. T.	C.	C.	C.	C.	C.T.	T.	S.	C.	C.	C.	C.	C.T.	T.	S.	C.	C.	C.	C.	C.T.	T.	S.
	N. or C.	C.	C.	C.	C.	C.C.	C	N.	C	C.	C.	C.	C.C.	C.	N.	C.	C.	C.	C.	C.C.	C	N.
Period.	Days	365	365	343	365	365	365	365	31	31	31	31	31	31	31	30	30	30	30	30	30	30
Load Factor.	Per Cent.	33⅓	22.3	33.6	46.4	34.8	52.2	47	33⅓	30	50.6	58.6	46.4	64	48.4	33⅓	17.7	28	43.2	27.6	42.6	43
	Per Cent. of S	....	67	101	139.5	104	157	141	....	90	152	176	140	192	145.5	....	53 2	84	130	83	128	129
Labor.	Shifts	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Duration	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
	Shift-hours	8,760	8,760	8,232	8,760	8,760	8,760	8,760	744	744	744	744	744	744	744	720	720	720	720	720	720	720
	Men per 1000 k w	1.94	4.67	2.91	3.36	1.9	4.79	5.95	1.94	4.66	2.95	3.24	1.93	4.93	6.36	1.94	4.96	3	3 8	1.77	4.5	6
Cost in Cts	Rate-pay	27	26.8	25.7	25.8	28.6	26.6	25.3	27.	26.5	26.2	25.	29.	25.8	25.6	27.	25.	25.6	24.4	28.4	27.6	24.2
	Per k w hour	.157	.56	.223	.187	.156	.243	.321	.157	.41	.153	.138	.121	.198	.336	.157	.705	.273	.215	.182	.292	.338
	Per Cent. total op	27.	46.7	32.5	29 4	22.6	28 7	29.1	27.	47.	27.2	23.	18.3	26.8	27.7	27.	51.4	40.6	32 5	25 9	31.8	31.7
	Per Cent. S	....	356	142	119	99.1	154	204	....	261	97.4	88	77	127	214	....	448	174	137	116	186	215
Fuel.	Lbs. per k w hour	2.2	3.18	2.48	2.61	2.86	3.24	4.13	2.2	3.07	2.86	2.65	2 74	3.19	4.74	2.2	3.3	2.34	2.48	2.84	3.3	4.05
	Price per short ton $	3	2.6	2.62	2.6	2.72	2.6	2.9	3	2.75	2.65	2.54	2.88	2.71	3.08	3	2.48	2.56	2.53	2.43	2.56	2.44
	Kind, A or B	B.	.3 A. .7 B.	.25 A. .75 B.	.3 A. .7 B.	B.	.2 A. .8 B.	B.	B.	.3 A. .7 B.	.25 A. .75 B.	.3 A. .7 B.	B.	.2 A. .8 B.	B.	B.	.3 A. .7 B.	.25 A. .75 B.	.3 A. .7 B.	B.	.2 A. .8 B.	B.
Cost in Cts	Per k w hour	.33	.414	.325	.340	.389	.42	.509	.33	.421	.313	.337	.395	.430	.729	.33	.409	.299	.314	.345	.423	.494
	Per Cent. total op	57.	34.5	47.4	51.6	55.2	49.7	54.3	57.	42.	55.6	56.4	59.9	58.4	60.1	57.	29.8	44.3	47.5	48.8	46.1	46.4
	Per Cent. S	....	125.5	98.5	103	117.5	127	182	....	127.5	94.5	102	120	130	220	....	124	91	95	104	128	140.5
Repairs, Supplies & Sup't. & Gen. Exp.	Per k w hour	.093	.225	.138	.132	.159	.182	.182	.093	.172	.0975	.123	.144	.109	.147	.093	.258	.102	.133	.176	.203	.233
	Per Cent. total op	16.	18.8	20.1	20.	22.6	21.6	16.5	16.	17.	17.2	20.6	21.81	14.8	12.2	16.	18.8	15.1	20.	25.1	22.1	21 9
	Per Cent. S	....	242	148	142	171	196	196	....	185	105	132	155	117	158	....	278	110	143	189	218	250
Total Oper. Cents.	Per k w hour	.58	1.198	.686	.679	.704	.845	1.102	.58	1.003	.563	.598	.66	.737	1.212	.58	1.372	.674	.662	.703	.918	1.065
	Per Cent. S	....	205	118	114	122	146	190	....	172.5	97.	103	114	127	208	....	236	116	114.5	121	157	184
Fixed Charges	Per k w hour	.405	....	....	....	....	....	....	.405	....	....	....	....	....	....	.405	....	....	....	....	....	....
	Per Cent. total op	70	....	....	....	....	....	....	70	....	....	....	....	....	....	70	....	....	....	....	....	....
	Per Cent. S	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Grand Total		.985	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

the relation of the costs, I have constructed diagrams, in which these are represented by different styles of lines, Figs. 3 and 4.

It will be noticed that these lines are of various heights, their height corresponding to the cost of the power in cents per kw hour. Four styles are used, that with horizontal shading showing the cost of coal, with vertical shading, cost of labor, and diagonal shading, general expense. These, which are operating expenses, are laid out above the line, and the solid black line showing fixed charges is plotted below the line. The distance from the base line o up to 1 represents 1 cent and the magnitude of each item is denoted by the length of its line. The diagram for table No. 1 is laid out in six groups, one group for each station. The first or left-hand column in each group represents the costs for the standard station. You will notice that its total length, including the solid black, is about equal to the distance between o and 1, so that including fixed charges the cost of power per kw hour per annum for the standard station amounts to about 1 cent. It also appears that the fixed charges are approximately equal to the coal. Labor is roughly about half the coal, and general expense about half the labor. These proportions are simple and easily remembered, and it will be seen that the pounds of coal per kw hour are 2.61 as against 2.2 for standard. This increase is, however, nearly balanced by the reduction in the price per ton, which was $2.60 as against $3 for standard. It might be expected that on account of the diminished size of the station the labor expense would be larger, on account of requiring more men per 1000 kilowatts. An examination of the table shows that the number of men per 1000 kilowatts is nearly double what is required for standard. This would double the labor expense, providing the rate of pay and load factor remained the same, but by a coincidence the rate of pay is lower and the load factor enough higher to bring the labor expense down to nearly standard figures.

To illustrate the effect of a high-load factor in reducing the cost of labor per kw hour, it will be interesting to look at the next column for this station, which represents the cost during January. In this month the load factor was 59 as against 46 for the year, and it will be noticed that the labor is reduced to less than the standard. The reduction in the total cost for this month, as against the yearly, is also apparent, and this is due principally to the reduction in labor.

TABLE No. 2.—DATA ON "OPERATION OF POWER STATIONS."

No. of Station.	S	10	11	12	13	14	15	16	17	18	19	23	25	26	28	29	30	31	32	33	34	35	37	40	42	43	44	45	47	48	50
Cap. in 1,000 k. w	3.6	.4	1.4	1.0	2.6	1.6	1.6	1.6	.8	.4	3.0	.6	4.0	.8	1.4	1.9	1.7	.9	5.3	1.5	2.0	1.2	1.5	9.2	1.8	3.9	6.0	1.0	.75	.6	
Type. Units E	3	2	5	3	4	4	4	8	2	2	6	2	10	7	4	5	5	3	5	4	4	1	3	6	3	5	6	4	4	2	
Type. Units G	3	2	8	7	4	4	16	8	4	3	6	2	19	12	8	5	5	3	30	12	.4	1	11	6	6	10	12	7	4	2	
Type. B. or D. C	D.C.	S. N.	B.	D.C.	B.	B. D.C.	B.	B.	B.	B.	D C	C.	S. N.	B.	B.	B.	C.	B.	B.	B. D.C.	D.C.	D.C.	B.	D.C.	B.	B.	B.	B D.C.	D.C.	D.C.	
Type. S. C. T. N. or C.	C.	N.	N.	C.	N.	C. N.C.	N.C.	C.	C.	N.	C.	C.	N.	N.	C.	C.	C.	C.	C.	C.	C.	C.	C.N.	C.	N.	C.	C.	C.	C.	C.	
Period—Days	365	1	365	365	365	365	183	365	365	365	81	183	865	865	81	365	365	365	367	365	183	365	151	365	365	365	365	30	183	365	
Load Factor—Per Cent	33⅓	24	×	23	42	19	41	33	×	23	×	16	33	19	23	27	23	32	31	16	57	37	11	36	45	15	30	28	×	35	
Taken from Car-miles																															
Shifts	3		2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Duration	8		12	12	12	12	12	8	12	12	12	12	12	12	12	10	10	10	12	12	12	12	12	12	12	12	12	10	12	12	
Shift-hours	8,760		8,760	8,760	8,760	8,760	4,380	8,760	8,760	8,760	744	4,380	8,760	8,760	744	7,300	7,300	7,300	8,760	8,760	4,392	8,760	3,624	8,760	8,760	8,760	8,760	600	4,380	7,300	
Men per 1,000 k. w	1.94	7.5	3.7	3.7	3.7	3.7	6.3	3.7	3.7	3.7	8.0	3.3	3.7	3.7	5.0	3.2	3.0	4.5	3.5	5.0	5.0	2.1	8.0	2.7	3.0	3.7	3.3	3.0	8.0	6.7	
Rate of Pay	27	18	20	20	20	22	16	20	18	12	17	25	51	37	17	21	21	21	20	20	20	26	16	29	26	16	24	15	12	15	
Cts. per k w Hr.	.157		.32	.31	.10	.15	.25	.23	.28		17	.51		.37	17	.25	.27	.23	.32	.62	.18	.15	1.1	.17	.30	.39	.26	.16	.41	.29	
Lbs. per k w Hr.	2		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Price ($) per Ton	3		2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Kind—A. or B		2 A. .5 B.	A.	B.	B.	B.	B.	B.	B.	B.	B.	B.	B.	B.	B.	B.	B.	B.	B.	B.	B.	B.	B.	A.	A.	B.	B.	B.	B.	B.	
Cts. per k w Hr	.83		.75	.63	.47		.68	.83	.36		.60	3.41	1.03	.29	.39	.55	.49	.62	.52	.66	.27	.29	.63	.24	.45	.30	.28	.25	.10	.17	
Gen. Ex.—Per k w Hr.	.003		.33	.11	.09			.14	.09	.06			.08	.06		.23	.15	.19	.09	.22	.12	.04	.12	.11	.18	.14	.15	.05	.21	.28	
Total Op.—Per k w Hr.	.88	1.5	1.4	1.05	.72		1.07	1.15					1.05	1.15	1.63	2.80	1.53	1.1		1.5	.57	.48	1.55	.53	.92	1.03	.69	.60	1.16	1.02	
Fixed Charges	.405			.44	.24																										

It will be seen that the coal expense is but slightly less and seems not to be reduced by the increased load factor. The explanation of this lies in the fact that the station is tied in with others, which keeps its load from fluctuating even on the low load factor. This will be still further exemplified by referring to a light month; the column at the right of the group gives the costs for September, during which the load factor was 43 as against 59 for January. The coal expense is still further diminished, and by reference to the table will be found to be due to an increase in the efficiency of the station. This might be found to be on account of not having to force the boilers. The increase of labor due to the low load factor is to be noticed.

I wish to say at this point that it is impossible for me in the limited time to give you more than a general idea of the large number of interesting facts which may be obtained by careful study of the tables.

Plant No. 2 is somewhat larger than the last and is equipped with two 1000-kw generators direct connected to compound condensing engines. It has also economizers and heaters. Its costs are in column No. 2. In looking at the yearly average it will be noticed that the total costs rise above the standard, which is due to an increase in labor and general expense. Coal as before is the same, the decreased efficiency being balanced by the lower price per ton. Examining the table with a view to accounting for the increase of labor we find the load factor approximately the same as standard, but an increase in the number of men per 1000 kilowatts. This is accounted for by the smaller size of the station. General expense is greater as would be expected. A glance at the diagram representing the heavy month for this station gives a nice illustration of the effect of the high load factor, which is 51 as against 33 for the year. It is to be noticed that the coal is practically the same, the reduction coming in the other two items.

This brings the total cost for the month below standard. In the light month with a low load factor of 28 per cent. the labor increase is very apparent.

I shall now present the costs of operation of a large station. Its equipment consists of six 1200-kw generators direct connected to triple condensing engines, two 1500-kw generators direct connected to compound condensing engines, and an auxiliary plant of forty 62-kw generators belted to compound non-condensing engines and used only in case of emergency. Economizers, heaters and electric feed pumps complete the important part of the equipment.

Group No. 4 indicates the costs for this station. The yearly average shows that we are approaching standard figures in labor. This item is not much less, as the units are only slightly greater capacity. Load factor, rate of pay and men per 1000 kilowatts correspond very closely with standard. The general expense and coal bring the total somewhat higher. General expense is high on account of the heavy repair account. The station is about eight years old and repairs are heavy, due to replacing of worn-out parts. The decrease in efficiency, as shown by pounds of coal per kw hour, might be shown by a test to be due to old boilers.

The plants just considered have all been direct connected. Station No. 5 is a belted plant, a little more than one-half the capacity of the standard, equipped with seven 340-kw generators belted to a countershaft, to which are belted three triple condensing engines, the auxiliary apparatus, affecting the economy of the station, being economizers and feed-water heaters. Diagram No. 5 represents the costs of a year, and also for the heavy and light months. During the three periods the coal expense remains about the same, but there is considerable variation in the other items, due principally to the change of load factor.

Notwithstanding the high load factor, 52 per cent., the labor for the year is still above standard. This would be expected from the multiplicity of parts to look after in a belted countershaft station. The reduction of general expense and labor in the heavy month is due to the load factor of 64 per cent.

Diagram No. 6 represents the costs for a belted plant of about one-fifth the capacity of standard. Its equipment is twelve generators belted to four simple high-speed non-condensing engines. There are feed-water heaters, but no economizer. High coal consumption is the feature of this diagram, the cost of fuel alone for the year being equal to the total operating expenses for standard. Labor is also high, and the total cost of power per kw hour is nearly double the operating expense of standard. This station furnishes a good illustration of the effect on the cost of power of a simple non-condensing belted equipment. It is to be remarked also that this plant has the benefit of a high load factor.

It will now be interesting to turn our attention to a small direct-connected station, which is numbered 1. This operates about thirty cars. It is equipped with three 200-kw generators and has compound condensing engines, heaters, but no economizers. It does not feed in with other stations, as do those which have been previously mentioned, and has a very fluctuating load, as may be imagined in the operating expenses for the year. An analysis of the items is given in column No. 12 of the table, and by comparing with standard the differences may be readily seen. I do not wish to be understood in making these comparisons that it would necessarily pay to make the changes required to effect this saving, my present idea being to bring clearly before you the differences.

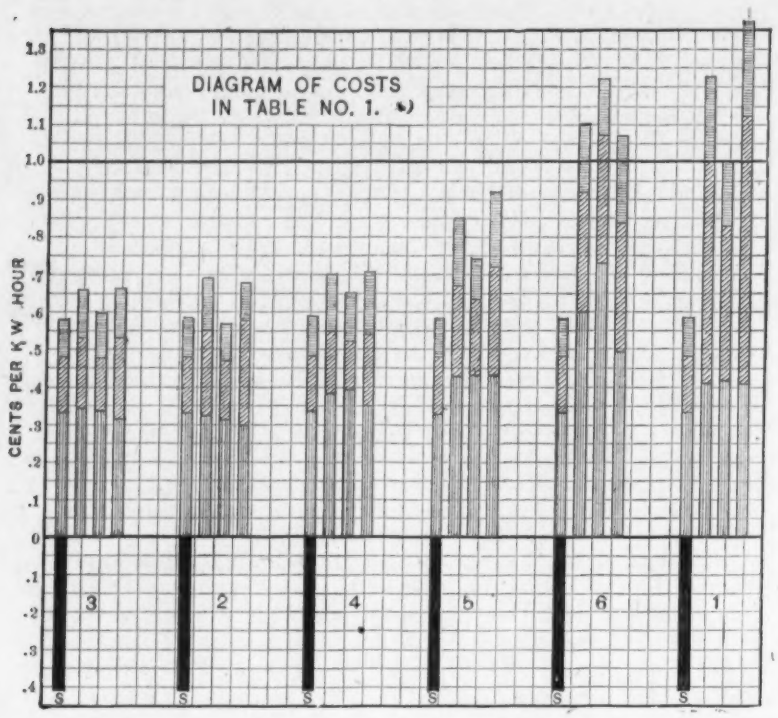


Fig. 3.

Station No. 13 is an interesting combination of cheap coal, simple non-condensing engines direct connected to the generators, together with a high load factor. Its capacity is 70 per cent. of the standard, major part being three 800-kw generators; the smaller unit is 200 kilowatts. It produced power to the extent of 42 per cent. of its capacity at 0.96 cent per kw hour, inclusive of depreciation and fixed charges. The depreciation is charged in at 5 per cent. on a capital expenditure of about $60 per kilowatt. The total expense for the year was $92,617.28, which is made up of

Labor	$15,453.25
Repairs and renewal of steam plant	1,839.69
" " " " electrical plant.	56.71
Fuel	44,780.94
Water	4,405.40
Oil, waste and lubricants	1,881.53
Tools, appliances and supplies	634.23
Taxes	1,945.65
Insurance	2,146.94
Interest	11,472.94
Depreciation 5 per cent. on $160,000	8,000.00
	$92,617.28

The analysis of these items is given for comparison with standard in column No. 13 of table No. 2. The diagram shows labor for this station to be equal to standard, principally on account of high load factor; the other differences are also apparent. It is interesting to note that the road operated by this power station used on an average of about 1.3 kw hours per car-mile. Total car-miles for the year was 7,207,308, about 10 per cent. of this mileage being trail cars. There are other interesting data about this road which time will not permit me to review.

Fig. 4.

agined in the operation of so small a number of cars. This station is just one-sixth the size of the standard, and it will be noticed that the column representing its operating expenses is about twice as high. The great increase is in the labor, although the station is operated by a corporation which has had a vast amount of experience in railroad work. Can we account for this increase in labor? By referring to the table we find the rate of pay of men is practically the same as standard; the load factor is low, 22 per cent., as against 33.

Referring to the heavy month for this station, which has the benefit of a 30-per cent. load factor, we find that the labor is reduced, but it is still a long way from bed-rock figures. The examination of the table discloses the fact that the increase comes in the men per 1000 kilowatts, being about 2.5 times the standard figure. The station records show the following men operating: On the first shift two engineers and one fireman, second shift one engineer, one oiler and one fireman, third shift one engineer and one fireman. Can this number of men be reduced? In a station whose equipment requires that the boilers be hand fired it is, to say the leaast, difficult to imagine that the boilers could be operated with less than one fireman per shift. The secret then for the large number of men per 1000 kilowatts lies in the small number of kw capacity. These same men could look after a station of greater capacity.

I shall next give the costs on plant No. 12, the figures of which are presented in table No. 2. This plant is about one-third the size of standard. It does not feed in with other stations. Its generators are belted to three tandem compound condensing engines which operate under steam pressure of 110 pounds. It has water-tube boilers averaging four years of service, heaters, but no economizers. A good quality of bituminous coal is used, which costs $2.93 per ton. By reference to the table it will be seen that this station produced power to the extent of 23 per cent. of its capacity during the past year at 1.49 cents per kw hour, including fixed charges, the operating expenses alone amounting to a little over one cent. The total cost of operation for the year was $23,000, of which $13,610 was for coal. Water costs this station nothing and the labor was about one-half the coal bill. By referring to the diagram No. 12, Fig. 4, it will be seen that the coal and labor are both much higher than standard, and if standard performance had been reached a saving of $10,000 would have been

Plant No. 15 is an interesting example of what a multiplicity of units will do for labor, the figure being 6.3 men per 1000 kilowatts.

The effect of this would be much more apparent on the diagram, were it not for the high-load factor and low rate of pay.

Plant No. 16 is of 1600-kw capacity. The cost for power for past year was $53,000. Load factor is the same as standard. Standard operates to produce about double the output for the same figure.

Station No. 28 is 1400-kw capacity, has slow-speed condensing engines, heaters and economizers. The feed water leaves economizer at the high temperature of 258°. The engines are simple belted to the generators and coal costs but $1.63 per ton.

Plant No. 29 is a compound condensing slow-speed belted station of 1900-kw capacity and feeds in with another station. The coal costs $3.86. Plants Nos. 30 and 31 are operated by the same corporation as No. 29.

No. 32 is a combination of two power houses feeding into the same system. These stations are interesting, because these costs are for the past year, and since then these two stations, as well as smaller ones operated by the same company, have been consolidated into a large water-power plant, from which power is transmitted at 13,000 volts. The two steam stations shown in column 32 have five triple-expansion condensing engines. This road operated on about 1.4 kw hours per car-mile. The coal costs $3 per ton. The water-power plant which replaced the steam has not been in operation long enough to enable its costs to be given.

Station No. 33 has rather a tall column, due principally to its low load factor of 16 per cent.

Station No. 34 operated at a lower cost than standard, on account of the high load factor 57 per cent., reducing the cost of labor and low price of coal $1 per ton.

No. 35 is a plant of 1200-kw capacity, interesting on account of the fact that it has but one unit. It operates with 2.1 men per 1000 kilowatts a load factor of 57 per cent., coal costing $1.24 per ton. Its costs are quite a little lower than standard.

No. 37 is a record breaker in the opposite sense. It is of slightly greater capacity than No. 35, but has three engines and eleven generators, which require eight men per 1000-kw capacity. It has a load factor of but 11 per cent. during 151 days from January 1 to May 31, 1898. The effect of this on the cost of labor is very apparent.

No. 40 has a capacity of 9200 kilowatts. It is direct connected, has economizers and compound condensing engines. Anthracite coal is burned, costing $1.60 per ton. This plant operates at less than standard figures.

No. 42 is a belted plant, compound non-condensing engines, heaters, but no economizers. It has a good load factor, but the effect of the belted and small units shows in all three items.

No. 43 is a combination of alternating and direct-current apparatus. It has a low load factor of 15 per cent., the effect of which is noticed on the labor.

No. 44 is a 6000-kw station, and, although belted, has large compound condensing engines and economizers, which, with coal at $1.60, brings the cost of fuel below standard figures.

It will now be instructive to take a general survey of the diagrams for all stations in table No. 2. No. 37 towers above all the rest. Standard is at the extreme left. Coal in No. 37 is greater than the total operating expense for standard. This station pays but $1.75 per ton, but it uses 7.3 pounds per kw hour. Compare this with No. 35, about the same size plant, paying $1.24 for coal and using but 4.7 pounds per kw hour.

I can hardly ask you to compare the labor, but it is easily seven times as large in No. 37 as in No. 35. The load factor of 11 per cent. as against 37 per cent. would make this item three times as great and men per 1000-kilowatt. Eight as against 2.1 would again increase the cost of labor three times. The higher rate of pay in plant No. 35 prevents the discrepancy being greater.

Let us look along the line for high coal cost. No. 16 seems to bear off the palm in this respect; $3.30 per ton and 5 pounds per kw hour accounts for this. For strikingly low costs we have Nos. 34, 35 and 40.

Electrical Concessions in New United States Territory.

Franchises for electric lighting and traction enterprises in Cuba and Porto Rico have been requested of the Government, but the War Department refuses as yet to grant them, on the ground that it is too early to complete industrial arrangements until the governmental affairs of the islands are more settled.

The Electrical Fixation of Nitrogen.*

BY SIR WILLIAM CROOKES.

My chief subject is of interest to the whole world—to every race—to every human being. It is of urgent importance to-day, and it is a life and death question for generations to come. I mean the question of food supply. Many of my statements you may think are of the alarmist order; certainly they are depressing, but they are founded on stubborn facts. They show that England and all civilized nations stand in deadly peril of not having enough to eat. As mouths multiply food resources dwindle. Land is a limited quantity, and the land that will grow wheat is absolutely dependent on difficult and capricious natural phenomena.

It is now recognized that all crops require what is called a "dominant" manure. Some need nitrogen, some potash, others phosphates. Wheat pre-eminently demands nitrogen, fixed in the form of ammonia or nitric acid. All other necessary constituents exist in the soil; but nitrogen is mainly of atmospheric origin, and is rendered "fixed' by a slow and precarious process which requires a combination of rare meteorological and geographical conditions to enable it to advance at a sufficiently rapid rate to become of commercial importance. There are several sources of available nitrogen.

The only available compound containing sufficient fixed nitrogen to be used on a world-wide scale as a nitrogenous manure is nitrate of soda, or Chili saltpetre. This substance occurs native over a narrow band of the plain of Tamarugal, in the northern provinces of Chili, between the Andes and the coast hills. In this rainless district for countless ages the continuous fixation of atmospheric nitrogen by the soil, its conversion into nitrate by the slow transformation of billions of nitrifying organisms, its combination with soda, and the crystallization of the nitrate have been steadily proceeding, until the nitrate fields of Chili have become of vast commercial importance, and promise to be of inestimably greater value in the future. The growing exports of nitrate from Chili at present amount to about 1,200,000 tons.

I have passed in review all the wheat-growing countries of the world, with the exception of those whose united supplies are so small as to make little appreciable difference to the argument. The situation may be summed up briefly thus: The world's demand for wheat—the leading breadstuff—increases in a crescendo ratio year by year. Gradually all the wheat-bearing land on the globe is appropriated to wheat growing, until we are within measurable distance of using the last available acre. We must then rely on nitrogenous manures to increase the fertility of the land under wheat, so as to raise the yield from the world's low average—12.7 bushels per acre—to a higher average. To do this efficiently and feed the bread-eaters for a few years will exhaust all the available store of nitrate of soda. For years past we have been spending fixed nitrogen at a culpably extravagant rate, heedless of the fact that it is fixed with extrême slowness and difficulty, while its liberation in the free state takes place always with rapidity and sometimes with explosive violence.

There is a gleam of light amid this darkness of despondency. In its free state nitrogen is one of the most abundant and pervading bodies on the face of the earth. Every square yard of the earth's surface has nitrogen gas pressing down on it to the extent of about 7 tons—but this is in the free state, and wheat demands it fixed. For years past attempts have been made to effect the fixation of atmospheric nitrogen, and some of the processes have met with sufficient partial success to warrant experimentalists in pushing their trials still further; but I think I am right in saying that no process has yet been brought to the notice of scientific or commercial men which can be considered successful either as regards cost or yield of product. The fixation of atmospheric nitrogen, therefore, is one of the great discoveries awaiting the ingenuity of chemists. It is certainly deeply important in its practical bearings on the future welfare and happiness of the civilized races of mankind. This unfulfilled problem, which so far has eluded the strenuous attempts of those who have tried to wrest the secret from nature, differs materially from other chemical discoveries which are in the air, so to speak, but are not yet matured. The fixation of nitrogen is vital to the progress of civilized humanity. Other discoveries minister to our increased intellectual comfort, luxury, or convenience; they serve to make life easier, to hasten the acquisition of wealth, or to save time, health or worry. The fixation of

*Extracts from the presidential address before the British Association for the Advancement of Science, Bristol, September, 1898.

nitrogen is a question of the not far distant future. Unless we can class it among certainties to come the great Caucasian race will cease to be foremost in the world, and will be squeezed out of existence by races to whom wheaten bread is not the staff of life.

Let me see if it is not possible even now to solve the momentous problem. As far back as 1892 I exhibited, at one of the soirées of the Royal Society, an experiment on "The Flame of Burning Nitrogen." I showed that nitrogen is a combustible gas, and the reason why when once ignited the flame does not spread through the atmosphere and deluge the world in a sea of nitric acid is that its igniting point is higher than the temperature of its flame—not, therefore, hot enough to set fire to the adjacent mixture. But by passing a strong induction current between terminals the air takes fire and continues to burn with a powerful flame, producing nitrous and nitric acids. This inconsiderable experiment may not unlikely lead to the development of a mighty industry destined to solve the great food problem. With the object of burning out nitrogen from air, so as to leave argon behind, Lord Rayleigh fitted up apparatus for performing the operation on a larger scale, and succeeded in effecting the union of 29.4 grammes of mixed nitrogen and oxygen at an expenditure of 1 horse-power. Following these figures, it would require one Board of Trade unit (kilowatt hour) to form 74 grammes of nitrate of soda, and, therefore, 14,000 units to form 1 ton. To generate electricity in the ordinary way, with steam engines and dynamos, it is now possible, with a steady load night and day and engines working at maximum efficiency, to produce current at a cost of one-third of a penny per Board of Trade unit. At this rate 1 ton of nitrate of soda would cost £26. But electricity from coal and steam engines is too costly for large industrial purposes; at Niagara, where water power is used, electricity can be sold at a profit for one-seventeenth of a penny per Board of Trade unit. At this rate nitrate of soda would cost not more than £5 per ton. But the limit of cost is not yet reached, and it must be remembered that the initial data are derived from small scale experiments, in which the object was not economy, but rather to demonstrate the practicability of the combustion method, and to utilize it for isolating argon. Even now electric nitrate at £5 a ton compares favorably with Chili nitrate at £7 10s. a ton; and all experience shows that when the road has been pointed out by a small laboratory experiment, the industrial operations that may follow are always conducted at a cost considerably lower than could be anticipated from the laboratory figures.

Before we decide that electric nitrate is a commercial possibility, a final question must be mooted. We are dealing with wholesale figures, and must take care that we are not simply shifting difficulties a little further back without really diminishing them. We start with a shortage of wheat, and the natural remedy is to put more land under cultivation. As the land cannot be stretched, and there is so much of it and no more, the object is to render the available area more productive by a dressing with nitrate of soda. But nitrate of soda is limited in quantity, and will soon be exhausted. Human ingenuity can contend even with these apparently hopeless difficulties. Nitrate can be produced artificially by the combustion of the atmosphere. Here we come to finality in one direction; our stores are inexhaustible. But how about electricity? Can we generate enough energy to produce 12,000,000 tons of nitrate of soda annually? A preliminary calculation shows that there need be no fear on that score; Niagara alone is capable of supplying the required electric energy without much lessening its mighty flow.

Acetylene and Calcium Carbide in France.

The consular report on this subject states that there are ten factories at present engaged in the manufacture of carbide in France and four more undergoing construction. The wholesale price of the carbide is given as about $70 per ton, exclusive of cost of packing, the retail price being about $5 per 100 pounds. There are two villages in France completely lighted by acetylene by the Société Franco-Espagnole du Gaz Acétyléne, 18 Rue St. Lazare, Paris. One of these is Alzonne, a town of 1500 inhabitants, and the other, Saurat-par-Tarascon, with 3000 inhabitants. The distribution of the gas is the same as with ordinary illuminating gas, but it is claimed that the French requirement for a franchise—namely, the lighting of the city free—is likely to cause the general introduction of independent generators in each house. The same report intimates that the carbide imported from America is a poor grade, and that this and the requirement of payment in advance precludes hope of any great advance in the consumption of the American product.

The Development of Wireless Telegraphy.*

BY SIR WILLIAM CROOKES.

The fundamental discovery by Hertz, of the electromagnetic waves predicted more than thirty years ago by Clerk Maxwell, seems likely to develop in the direction of a practical application which excites keen interest—I mean the application to electric signaling across moderate distances without connecting wires. The feasibility of this method of signaling has been demonstrated by several experimenters at more than one meeting of the British Association, though most elaborately and with many optical refinements by Oliver Lodge, at the Oxford meeting in 1894. But not until Signor Marconi induced the British Post Office and foreign governments to try large scale experiments did wireless signaling become generally and popularly known or practically developed as a special kind of telegraphy. Its feasibility depends on the discovery of a singularly sensitive detector for Hertz waves—a detector whose sensitiveness in some cases seems almost to compare with that of the eye itself. The fact noticed by Oliver Lodge in 1889, that an infinitesimal metallic gap subjected to an electric jerk became conducting, so as to complete an electric circuit, was rediscovered soon afterward in a more tangible and definite form and applied to the detection of Hertz waves by M. E. Branly. Oliver Lodge then continued the work, and produced the vacuum filing-tube coherers with automatic tapper-back, which are of acknowledged practical service. It is this varying continuity of contact under the influence of extremely feeble electric stimulus alternating with mechanical tremor, which, in combination with the mode of producing the waves revealed by Hertz, constitutes the essential and fundamental feature of "wireless telegraphy." There is a curious and widely spread misapprehension about coherers, to the effect that to make a coherer work the wave must fall upon it. Oliver Lodge has disproved this fallacy. Let the wave fall on a suitable receiver, such as a metallic wire or, better still, on an arrangement of metal wings resembling a Hertz sender, and the waves set up oscillating currents which may be led by wires (inclosed in metal pipes) to the coherer. The coherer acts apparently by a species of end-impact of the oscillatory current, and does not need to be attacked in the flank by the waves themselves. This interesting method of signaling—already developing in Marconi's hands into a successful practical system which inevitably will be largely used in lighthouse and marine work—presents more analogy to optical signals by flash-light than to what is usually understood as electric telegraphy; notwithstanding the fact that an ordinary Morse instrument at one end responds to the movements of a key at the other, or, as arranged by Alexander Muirhead, a siphon recorder responds to an automatic transmitter at about the rate of slow cable telegraphy. But, although no apparent optical apparatus is employed, it remains true that the impulse travels from sender to receiver by essentially the same process as that which enables a flash of magnesium powder to excite a distant eye.

The Resistance of the Human Body.

Experiments to determine the resistance of the body to the passage of electric currents are described in a communication from Mr. James E. Boyd, of the Ohio State University, to the "Physical Review," August, 1898. The experiments were made with both direct and alternating currents, the circuit being from hand to hand, contact being made by immersing the four fingers of each hand in salammoniac solution. With alternating currents the resistance was obtained by measuring with a dynamometer the current flowing through a given resistance and with the same voltage that flowing through the body. With e. m. fs. varying from 4 to 6.8 volts, the resistance was found to be practically independent of the current flowing, averaging 1550 ohms, the current varying from 2.6 to 4.4 milamperes. With direct currents the resistance of the contacts was eliminated by using the fall of potential method, the measured currents being passed through the body and fall of potential between wrist and wrist, or any parts desired being measured by means of a condenser and galvanometer, the fall of potential without current being subtracted from that with current to eliminate any electrolytic effect. With about 1½ volts and 0.8 of 1 milampere the resistance from wrist to wrist was found to be about 625 ohms. From the liquid in the jar to the adjacent wrist a value of 350 ohms was found, giving a total resistance from jar to jar of about 1325 ohms. Other resistances found were those from wrist to elbow, 200 ohms; from wrist to end of shoulder blade, 267, and from shoulder to instep, 291.

*Extracts from the presidential address before the British Association for the Advancement of Science, Bristol, September, 1898.

The Annual Meeting of the Association of Edison Illuminating Companies.

The nineteenth convention of the association of Edison Illuminating Companies was held at the Hotel Iroquois, Sault Ste. Marie, Mich., September 12 and 13. There was a large attendance and the convention was a success, both in respect of work done and in its social features.

The first meeting was opened promptly at 9 A. M. Monday, September 12, by President Samuel Insull. There was no formal presidential address. After roll call the representatives of the Edison companies of Detroit, Chicago, Brooklyn, New York and Boston stated their experiences during the past year and their present practice in the making of rates for supply, especially the low rates for long-hour use, particular reference being made to the Wright and the two-rate methods of charging. The statements showed great diversity in methods, but good results invariably follow readjustment in favor of long-hour consumers. The discussion was general and was by consent reopened the next day. At Monday evening's session Mr. W. S. Barstow described the Brooklyn multiphase system in detail. He was followed by Mr. J. W. Lieb, Jr., who reported what the engineering commission recently sent to Europe by the Edison Electric Illuminating Company of New York, consisting of Mr. Lieb, Mr. John Van Vleck, and Mr. Arthur Williams, saw there of electrical and mechanical interest. The discussion was opened by Mr. Herbert A. Wagner, of St. Louis, and had reference largely to alternating current practice.

On Tuesday morning Mr. Arthur Williams spoke of European practice in meters and charging systems, lamps, fixtures and details, as observed by the New York Company's commission. His talk was followed by three papers on meters and metering, by Mr. E. A. Leslie and Mr. Charles S. Shepard, of New York, and Mr. Oliver J. Bushnell, of Chicago. These were replied to by Mr. Caryl D. Haskins, of the General Electric Company, and discussed very fully by Messrs. Scovil (Cleveland), Huntington (Spokane), Chandler (Sault Ste. Marie), Barstow (Brooklyn), and Ferguson (Chicago). A special afternoon session was found necessary, at which the discussion of meters and metering was continued; two papers were read by Mr. C. C. Perry, of Indianapolis, and Mr. W. F. Kingan, of Sault Ste. Marie, on the problems of smaller stations; and a very full report was presented by Mr. Chandler from the association's committee on Welsbach burners and acetylene gas (Messrs. Stetson, Chandler and Leslie).

The last session, held Tuesday evening, received and considered the reports of the Executive Committee, the Committee on Incandescent Lamps, and the Lamp Testing Bureau. The final business was the election of officers for the ensuing year, who are as follows:

President, R. R. Bowker, New York; vice-president, G. R. Stetson, New Bedford, Mass.; treasurer, W. S. Barstow, Brooklyn; secretary, Wilson S. Howell, Newark, N. J. (Post Office Box 114).

Executive Committee—Samuel Insull, Chicago; Charles L. Edgar, Boston, Mass.; J. W. Lieb, Jr., New York; Alex. Dow, Detroit; J. H. Vail, Philadelphia.

The greater part of the attendants at the convention arrived at Sault Ste. Marie by the steamer Northwest Sunday evening and returned by the same steamer, leaving Wednesday afternoon. The lake trip was highly enjoyed and was one of the most pleasant features of the convention of 1898, especially as it afforded opportunity for a good deal of interchange of opinions and experiences. At Mackinac Island, on the upward trip, the delegates and the ladies of the party were entertained by a carriage ride to points of interest, the invitation being tendered by the General Electric Company. At the "Soo" the Edison-Sault Company arranged carriage and steamboat excursions and also provided canoes and Indian guides to carry the more venturesome members of the party through the rapids of the St. Mary's River. The thanks of the ladies and of the association were tendered to the Sault Company and to the General Electric Company for these courtesies.

They Might Carry the Lines Also.

In Berlin, Germany, a new system of fire-department communication has been established with alarm boxes, into which telephone instruments can be plugged. It seems that each fire captain carries a small (?) leather box containing a telephone receiver, a microphone and induction coil, with automatic switch, and a condenser and battery. Just why the captains are required to carry these on their persons does not appear.

Convention of the New York State Street Railway Association.

The sixteenth annual meeting of the Street Railway Association of the State of New York was held at the Manhattan Beach Hotel, Manhattan Beach, New York city, on Tuesday and Wednesday, September 13 and 14, 1898.

The meeting was a remarkably pleasant one, the location being a recreation resort admirably suited for the accommodation of a convention and, owing to the lateness of the season, not crowded with other guests. The weather was fair and cool, the papers and the discussions were on subjects of vital interest and full of valuable suggestions to their hearers, and the entertainments were exceptionally attractive and interesting.

TUESDAY, SEPTEMBER 13.

The meeting was called to order by the president, Mr. G. T. Rogers, of Binghamton, at 11:15 A. M., about thirty members being present, besides several invited guests, among them the railroad commissioners of the State of New York and the usual following of supply men, representatives of the press, etc.

After the transaction of routine business President Rogers read his annual address, which may be briefly abstracted as follows:

THE ADDRESS OF THE PRESIDENT.

"I wish at the outset to mention a calamity which has recently overtaken us. Since our last annual meeting an Almighty Power has seen fit to call to his long rest our beloved and respected attorney, the Hon. Edmund O'Connor, in the death of whom the people of this State, as well as our association, have suffered an irreparable loss. The Street Railway Association of the State of New York is stronger, larger and more representative than ever before. Each year our conventions are more largely attended, and more interest is shown in the work. The affairs of the association at Albany have been conducted during the past year by the executive committee in a most conservative, dignified and frank manner.

"Rapid transit in large cities has exerted a marked influence for the health, comfort and welfare of the resident poor and working classes, and has resulted in an equalization of real estate values, thereby avoiding a congestion of the population that has existed in the past, and creating better living conditions for all. It has opened up large areas of valuable properties hitherto inaccessible, but now within time distance of important and objective points.

"The local transportation companies are fairly entitled to the public aid and encouragement, which has in many instances been grudgingly given, as numerous difficulties have demonstrated.

"The return upon the capital invested in street railway enterprises is generally overestimated by the public; many lines are constructed or extended and operated at an actual loss for years, but I believe that the public begins to see and appreciate the great advantage on its side, and that a more liberal policy will prevail.

"In relation to rapid transit and its development in Brooklyn, I might mention that the operation of through cars from the remotest districts of Brooklyn direct to City Hall, Manhattan, is now an accomplished fact. Nothing was more needful for the convenience of the residents of Brooklyn and the building up of its outlying territory than a quick and convenient mode of transportation to New York. That it has filled a long-felt want is evidenced by the tremendous popularity it has attained. The number of people carried back and forth seems to be limited only by the number of cars which can be operated with celerity and safety.

"In my address of 1896 I stated that the great city of New York was far behind all other cities of the State in modern transportation facilities. It was my pleasure at the last convention to call your attention to the progress made in the installation of improved motive powers in the old city of New York. It then appeared that the State Board of Railroad Commissioners had authorized the use of electricity upon railroads covering 110 miles of track. Since that time the railroads have put in operation over 86 miles of trackage, of which 54 miles have been constructed and completed during the present year.

"The rapid track construction in the city of New York, involving as it does the reconstruction of sewers, changing and laying gas and water pipes, has been one of the noticeable features in railroad history, and deserving of great commendation, which has been bestowed by the New York press. The reconstruction of the Sixth and Eighth Avenue lines in twenty-five days after the ground was broken on July 20, so as to permit of the temporary operation of horse cars to the shopping centres for the convenience of the public, is a record unparalleled in city railroad construction. With

a power house costing $3,000,000, New York city will be furnished with a system of transportation that may well be envied by all roads of the country.

"At the present moment the Metropolitan Street Railway Company is engaged in reconstructing 22 additional miles of trackage for operation by electricity, leaving a balance of 120 miles of the Metropolitan system and 114 miles of the Third Avenue system yet to be transformed.

"The interest in the cable system is now purely historical. It has served its purpose and served it well, but its day is done. From the railway standpoint there is nothing to be hoped from it, but we all look back on it with gratitude, as it was first instrumental in displacing the horse.

"Its availability for overcoming heavy grades cheaply remains unimpaired, but its merit for average transportation has been excelled by electric system."

Following the president's address the treasurer submitted a report showing the gross receipts for the past year to be $6,205, the balance on hand from the year before being $1,359.71. The disbursements during the past year were $6,400.26, leaving a balance on hand of $1,164.45. The report of the executive committee was also presented.

The first paper read was one by Mr. H. M. Kennedy, entitled

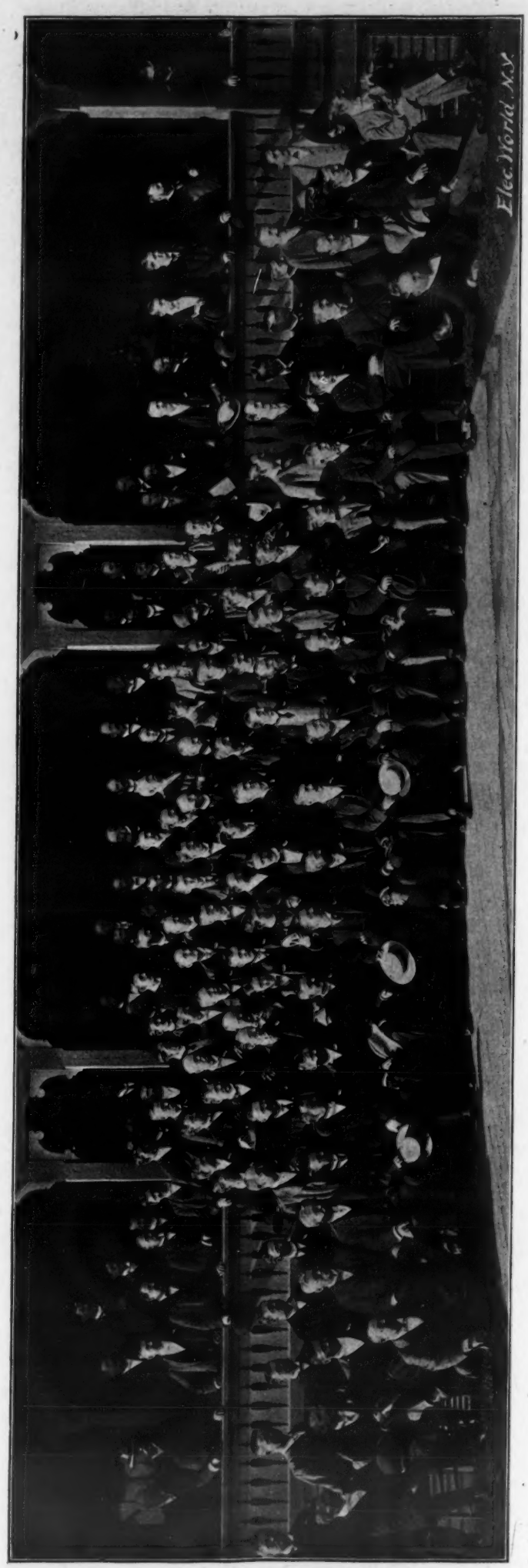
METHODS OF DEVELOPING NEW TRAFFIC ON STREET RAILWAYS.

The writer pointed out the increase of business obtainable by proper methods of advertising and encouraging street railway riding. He advised the establishment of a suitable "special traffic" or "general passenger" department to undertake this work. He pointed out the duties of this department in obtaining favorable press notices, establishing special trolley party traffic in parlor, buffet and specially illuminated cars, and went into the subject of pleasure resorts. In this connection he described particularly the resorts reached by the Brooklyn companies, notably Bergen Beach, North Beach, etc., which are not managed directly by the companies, but which are encouraged in advertising and other ways by co-operation and division of the expense, special advertising on the cars, etc. The paper closed as follows: "But special cars, pleasure resorts, advertising and co-operation are not the only methods for developing new traffic. Clean, ample cars, through lines and generally efficient service are requisites to satisfy those who are induced to patronize the road and hold those who are already patrons, making it such a pleasure to travel that they would rather be on the road than at home."

In the discussion of this paper Mr. T. L. Johnson, president of the Nassau road in Brooklyn, stated that some three years ago his road introduced a uniform 5-cent fare, and that last year it had practically a monopoly of the business to Coney Island. This season the other system in Brooklyn, representing 75 per cent. of the carrying capacity of Brooklyn lines, have gone into Coney Island, Bergen Beach and other resorts; but notwithstanding this the Nassau business has increased steadily, which shows that the traffic will grow as inducements are offered. The Sunday business has been only limited by the capacity of the lines. Mr. Johnson also described a rather unusual car in use on his road, consisting of a single-truck car body 31 feet in length, with ten benches arranged vis-a-vis, and with six exits, two at the platforms and four side doors, and one side solid with glass. By letting down the end windows the car can be made as cool as an open car in summer, and rendered more weatherproof than a closed car in winter. The glass side is intended to be replaced during the hot months by one long curtain to be controlled by the motorman or conductor. About 250 of these cars will be on the road by the 1st of October.

President H. H. Vreeland, of the Metropolitan Street Railway Company, of New York city, said that that company did not have to stimulate travel, but found it difficult to accommodate that which naturally came to it. Speaking of other lines with which he was connected, he described the Atlantic Coast line and its successful experiment in an amusement resort at Pleasure Bay, near Long Branch, but stated that, as a rule, he believed in the old saw "Shoemakers, stick to your last."

Mr. J. P. E. Clark described the work of the Binghamton Company with two parks which, he said, increased the average monthly receipts of the road from $10,000 or $12,000 in the winter to $22,000 or $23,000 during the five summer months. One of these is a park owned by the city, the features being provided by the company; the other is owned and operated entirely by the company, and is 9 miles from the city, the round trip fare being 25 cents.



DELEGATES OF THE NEW YORK STATE STREET RAILWAY ASSOCIATION AT MANHATTAN BEACH.

Following the discussion a paper was read by Mr. H. S. Cooper on

A SIGNAL SYSTEM FOR SINGLE TRACK ROADS.

Where an electric road is similar in conditions to steam roads, and where its traffic will warrant the outlay, steam road signal and safety systems may, of course, be adopted; but most electric roads are not conditioned in this way and other systems must be used. Certain requirements are essential to success, as follows: 1. Reasonable cost of installation and maintenance; 2, simplicity in construction and operation; 3, proof against frost, sand, dust, mud, sleet, sun, snow, water, oil and ordinary tampering; 4, reliability and inability to give safety signals when out of order; 5, capability of being used as a signal between two points at the same time. The uses of such a system would naturally be mainly to prevent collisions, as a dispatching system and as a means of communication. In connection with the first use collisions are not likely to occur at terminals and switches, but mainly at the intermediate runs. The only system which has yet appeared to be satisfactory to the writer is a simple telephonic dispatch system.

In the discussion of this paper Mr. James A. Powers described the difficulties found in his experience with single-track roads requiring that motormen should be absolutely forbidden to run by switches under any circumstances. If the telephone line breaks down the cars wait until they get orders in some other way. This blocks traffic and limits the schedule capacity of the road and necessitates a system of double heading the cars, or large cars. The Stillwater and Mechanicville line is using 15-bench open cars, seating ninety passengers and carrying fully 130 to 150 passengers per car. Great need is felt for a system by which it would be impossible for a car to enter upon a block already occupied without becoming derailed, but there has been no satisfactory apparatus offered as yet.

Further discussion brought out the general opinion that the best means of solving the signal system problem on single-track roads is to double track them.

The next paper read was one by Dr. M. M. Fenner, entitled

BY-PRODUCTS OF THE POWER HOUSE.

The one by-product discussed in this paper was exhaust steam, the efforts to make use of which by the Dunkirk & Fredonia Railroad were described in detail. In the winter season of 1893-4 the road sold its exhaust steam for the purpose of heating a hotel immediately across the street from the company's power house. The system used was found to be a flat failure, and the company was compelled to heat the building with live steam injected into the exhaust with sufficient pressure to compel the circulation. During the summer of 1894 the railway company made an investigation and requested the experience of several others, notably that of the Buffalo Electric Lighting Company, some reports being absolutely discouraging, but others, notably those from the users of one system, were more hopeful. The company went ahead and put in this system and also added an electric light and power plant. The capital of the company had increased from $57,000, when it was operating a horse railroad, to $116,200, and it had acquired a bonded 5 per cent. debt of $61,000, but 6 per cent. was paid on the increased capital. Of this 3 per cent. came from the railroad returns and 3 per cent. from the sale of exhaust steam. It was sold by meter at a rate based upon $4.17 per ton for a high-grade anthracite coal, and at this rate users preferred it to their own heating plants. The back pressure is about four to six pounds, thus giving ample circulation at considerable distances, with the aid of the partial vacuo caused by condensation, the condensed water being trapped to the sewer. The back pressure makes no noticeable difference in the coal consumption. The system has been found profitable and satisfactory in every way. The underground steam distribution is effected by the Holly system as installed by the American District Steam Company, of Lockport, N. Y., wherein the steam pipe is placed on rests 1 inch high, within bored logs, the bore being 2 inches greater than the external diameter of the pipe, so as to give 1 inch of dead air, the pipe itself being wrapped with asbestos. The log has a shell 4 inches thick soaked with preserving materials and lined with tin, which is covered with three-ply tar roofing felt, the whole being laid on a board at the bottom of a trench 5 feet deep. Expansion joints are inserted at proper intervals with brickwork above them, proper tile drainage being placed beneath the structure to carry off the water. A rough rule for the amount of heating which a power plant may do with its exhaust steam is to figure on 10,000 cubic feet of space in average buildings per horse-power. At the rate of $13 per thousand cubic feet this would give $30 per horse-power year. The system is adaptable to all sorts of consumers, and during the hours when the steam consumption of the engines is small it may be supplemented by live steam at small cost, owing to the fact that the load on the boiler equipment is thereby rendered much more uniform.

The meeting then adjourned until afternoon.

AFTERNOON SESSION.

In the discussion of Mr. Fenner's paper Mr. W. J. Clark spoke of the combined working of the railway and lighting business, stating that in New England the electric lighting concerns have been very careful to see that electric railways did not get the right to encroach upon their business. In the West, however, a great many systems are worked together, and wherever it has been tried in smaller places the combination, as a rule, has been found advantageous, producing economies which would be impossible in running two small systems independently.

Prof. R. C. Carpenter stated that the profit from exhaust steam would depend largely on the nature of the engine. With an economical compound condensing engine from which a hp hour can be obtained from 2 to 4 pounds of coal, it would, as a rule, not pay to attempt to use the exhaust steam for heating purposes. He also cited Ithaca and Cortland, N. Y., as instances where the power stations for the lighting and railway service have been combined with great advantages. In each case the two systems are run by two companies, having, however, common stockholders and common officers. He cited tests made at Cornell University of heat insulation, showing that the best results practically attainable reduced the condensation to about one-fifth of that in pipes exposed to the open air. In open air exposure about one-third of a pound of steam is condensed for each square foot of surface.

In answer to a question as to the distance to which steam can be economically carried, Mr. Fenner stated that at Cedar Rapids, Ia., the exhaust is carried over a mile to the centre of distribution and used satisfactorily.

Following the discussion, Mr. G. E. Chapin read a paper on "Track Bonding," prepared by Mr. R. P. Brown and himself, a reprint of which will be found in another column.

After a brief discussion Mr. W. J. Clark read a paper on "Electric Railways as Auxiliary to Coast Defenses," an abstract of which will be published later in these columns. Papers were also presented on "Rails; Their Construction from a Scientific Standpoint," by Mr. Moxham, and on "Track Construction," by Mr. G. F. Carver. Abstracts of these papers will also appear later.

In the discussion of the latter paper, Mr. H. H. Littell, of Buffalo, spoke of 5 miles of track which the Buffalo Railway Company had installed in 1897 without any ties. A trench was dug 20 inches wide and 17 inches deep, and the 60-pound rails, with staggered joints, suspended above it, and adjusted to line and gauge by a clamping appliance. Concrete made up of Portland cement and fine broken stone was then tamped under the rail and filled to a level just above that of the base of the rail. After twenty-four hours the clamping appliances were removed. The track has proved perfectly solid, there being not the slightest sign of movement, and it is difficult to find a joint. Seventeen miles of road had been laid in Buffalo with the concrete base laid first and the rail placed on top of it, and filled with Portland cement mortar. This is not as satisfactory. Concrete foundation is, however, difficult to install where the track must be hurriedly used. In some track lately relaid a tie was put in every 10 feet to preserve alignment, the concrete being tamped under the ties as well as under the whole rail. Such track can be used five or six days after being laid, and in the Buffalo piece it is very difficult to find the joints. They were laid as tight as they could be.

THE DISCUSSION OF STORAGE BATTERIES.

The question of storage batteries coming up, Mr. Littell spoke of the big Buffalo installation, which has been in use about nine months. The battery installation is rated at 1200 hp hours, the steam plant having a nominal output of 7000 horse-power and 2000-hp supply coming in from Niagara. The battery trays are sufficiently large for an increase of 67 per cent., and this increase will probably soon be made. The company is very much pleased with the operation. It has the same effect as a safety valve on the steam boiler or a standpipe on a water works; it takes the sudden impulses. There have been instances where with but one 1200-hp engine running and 2000 horse-power coming in from the Falls, the latter has been unexpectedly shut down, but the cars went on and the people did not know it. The battery held the load for fifteen

or twenty minutes until more engines could be put in. The battery has carried the night load for three or four hours alone.

Mr. H. H. Vreeland stated that as a result of considerable experience with batteries in Philadelphia and Pittsburg the Metropolitan Street Railway Company of New York city has just contracted for one of the largest plants that has ever been erected for a street railway company. The situation of this company is peculiar. It is building a power house of 70,000 horse-power, which will not be ready until next spring. The temporary generators now in use or under erection will not carry the load through the winter, and a storage battery auxiliary is to be put in to be worked permanently with the large plant when that is in service. The experience of plants throughout the country with storage batteries has shown that they are economical auxiliaries wherever the power capacity is reached in the heavy hours.

In answer to a question, Mr. Littell expressed the opinion that any small road running from thirty to fifty cars would be justified in putting in a storage battery.

At the conclusion of this discussion, Mr. T. J. Little, of New York, read a paper on "The Relation Between the People and the Street Railways," after which a nominating committee was appointed, consisting of Mr. H. H. Littell, of Buffalo; Mr. Ira A. McCormack, of Brooklyn, and Mr. F. D. Rounds, of New York.

The convention then adjourned for the day.

WEDNESDAY, SEPTEMBER 14.

The meeting was called to order at 10:15 A. M., the first business being the report of the nominating committee, the nominations of which were as follows: President, G. Tracy Rogers, Binghamton, N. Y.; first vice-president, W. Caryl Ely, Niagara Falls, N. Y.; second vice-president, Albert L. Johnson, Brooklyn; secretary and treasurer, Henry A. Robinson, New York. Executive committee: Herbert H. Vreeland, New York; John W. McNamara, Albany; Henry M. Watson, Buffalo; Clinton L. Rossiter, Brooklyn. A unanimous ballot was cast for the officers nominated.

Ithaca was chosen as the next place of meeting of the association, the meeting to be on Tuesday and Wednesday, September 12 and 13, 1899, according to the by-laws.

On the request for a few remarks, Mr. K. Sugahara, chief engineer of several street railroads soon to be built in Japan, spoke on somewhat the same lines as his address before the American Street Railway Association.*

After thanking the Brooklyn companies for their courtesies, the convention adjourned.

THE BANQUET.

On Tuesday evening, after the display of Pain's fireworks, the delegates sat down to a banquet at the Manhattan Beach Hotel. The Hon. T. L. Johnson was toastmaster. President Vreeland responded to the toast "Transportation in Greater New York," saying that the street railways in Greater New York collect 600,000,000 5-cent fares per year, of which three-fourths are taken in on Manhattan Island. Other toasts were proposed and responded to as follows: "Our Best Patrons, the Ladies," by A. B. Colvin; "The Busy Boys, Our Legislators," by State Senator J. A. Cantor; "Our Host," by J. H. Stedman; "A Necessary Evil, the Lawyers," by J. Aspinall; "Our Association," by W. Caryl Ely.

WEDNESDAY'S ENTERTAINMENTS.

At 11 o'clock, after the adjournment of Wednesday morning's session, the delegates boarded electric cars and were carried over various interesting lines through Brooklyn to the Brooklyn Navy Yard. Here they saw several of Uncle Sam's warships lately returned from active service, but were disappointed in not being permitted to board them. From here the party was taken to the bridge dock, where it embarked for a trip around Manhattan Island. The trip was greatly enjoyed, and those locally acquainted were kept busy pointing out the objects of electrical, and particularly of electric railway, interest on the route. Among these were the mammoth Eastern District power house of the Brooklyn Rapid Transit Company, the new generating plant of the Kings County Electric Light & Power Company, the partially constructed 70,000-hp power house of the Metropolitan Street Railway Company, the combined railway and lighting plant of the New York & Queens County Company, the terminal car storage structure and temporary electric and compressed air power house of the Metropolitan Street Railway Company on One Hundred and Forty-sixth Street, and the enormous car house and power plant built for the Kingsbridge extension of the Third Avenue Railroad Company, but never used, owing to franchise litigation. The shores of New York Harbor are rapidly becoming studded with large plants for the generation of electricity, and had the convention gone down the bay instead of up the river it would have passed the power house of the Nassau Railroad, the southern station of the Brooklyn Rapid Transit Company, the new high-tension multiphase central generating station built by the Brooklyn Edison Company and the combined railway and lighting station of the New York & Staten Island Electric Company.

*See The Electrical World of September 17, 1898, page 288.

Exhibits and Notes.

MR. C. W. OLDS represented the American Blower Company, 141 Broadway, New York.

MESSRS. J. E. WALLACE and J. L. Lawton represented the Smith-Wallace Supply Company, Boston.

MR. KORAN SUGAHARA, an electrical engineer of Japan, was an interested attendant at the convention.

THE COLUMBIA MACHINE WORKS, Brooklyn, N. Y., were ably represented by Mr. W. R. Kerschner.

MR. J. S. BRADLEY looked after the interests of the New Haven Car Register Company, New Haven, Conn.

PROF. R. C. CARPENTER, of Sibley College, Cornell University, was a visitor at the meetings of the Street Railway Association.

MR. W. J. CLARK, of the General Electric Company, was in attendance at the convention, and participated in the discussion of the papers presented.

MESSRS. THOMAS H. BIBBER and Herbert W. Smith were present in behalf of the Bibber-White Company, Boston, and made an exhibit of a general line of electric railway supplies.

THE KEYSTONE ELECTRICAL INSTRUMENT COMPANY, Philadelphia, was represented by Mr. J. F. Stevens. Many good things come from the Quaker City, among them being Keystone instruments.

THE ECONOMIES obtainable through the use of storage batteries in railway work were brought to the attention of the delegates by Mr. Charles Blizzard, who represented the Electric Storage Battery Company.

MESSRS. WENDELL & MacDUFFIE, New York, sent Mr. J. H. Wright down to Manhattan Beach to represent them. Both Messrs. Wendell and MacDuffie accompanied the party on the boat ride around the harbor.

THE CONSOLIDATED CAR HEATING COMPANY, Albany, N. Y., was present in the person of Mr. H. N. Ransom, who reminded the street railway men that cold weather was approaching and that they would need some heating apparatus for their cars.

MR. H. B. CUTTER, president of the Cutter Electrical & Manufacturing Company, Philadelphia, Pa., was an attendant at the convention. He visited the Brooklyn Navy Yard with the party on Wednesday, but was unable to take the sail around the harbor.

THE SAFETY THIRD RAIL ELECTRIC COMPANY, New York, was represented by Capt. J. McLeod Murphy and Messrs. William Duvoe, John Cokeley, Frank Murphy and E. V. Baillard. An operative model of the system was shown, and it excited much interest among the delegates.

MESSRS. GEORGE A. PARMENTER & CO., of Cambridgeport, Mass., were represented by Mr. Parmenter, who had an exhibit of a Parmenter fender and wheel guard. Over 2000 of this firm's fenders and wheel guards are in practical operation on electric railways throughout the United States.

MR. J. EMORY MEEK looked after the interests of the H. W. Johns Manufacturing Company at the convention. He did some effective work among the street railway men present. Mr. A. Hall Berry, manager of the electrical department of the same company, dropped in on the convention and met the delegates.

THE FALK MANUFACTURING COMPANY, Milwaukee, Wis., represented by Mr. J. Z. George, showed an auto-motoneer, which device is designed to avoid the needless waste of current in starting cars. The apparatus was briefly described in the last issue of The Electrical World in connection with the Falk Company's exhibit at the Boston convention.

MR. W. I. THOMSON, of the firm of Wilson, Thomson & Co., 313-315 Fulton Street, Brooklyn, N. Y., showed the Wilson patent trolley pole catcher and reel, manufactured by the firm above named. The object of this device is to catch and hold the trolley pole whenever the trolley wheel jumps the wire. It, therefore, prevents damage to overhead wires, etc. The clock spring inside of the case keeps the rope taut at all times. This device was described and illustrated in The Electrical World of February 19, 1898.

MR. GEORGE L. CAMPBELL, manager of the Campbell Electric Traction Company, Tonawanda, Pa., had intended to show a model of the Campbell system of electric traction, but unfortunately the model was damaged in transit. He, however, explained the system to the delegates. The conduit of this system is a continuous body (air and water tight), about 6x9 inches in cross section, and rests upon the top of the ties. A continuous electrical conductor lies on the bottom of the conduit, inside. The top of the conduit, which is composed of sections of metal 8 feet long, but insulated from the rest of the structure, is brought into electrical contact with the conductor by means of a specially designed trolley or traveler, which runs in the conduit, the movement of the trolley being controlled by a pair of strong electromagnets in the car. A metal shoe suspended from the car presses on the top of the conduit and conveys the current to the motor. It is evident, therefore, that no part of the conduit surface is alive except the 8-foot length immediately under the car. The advantages claimed for the Campbell system are: (1) no excavation is needed to install the conduit; (2) cheapness of installation, and (3) simplicity of construction. From these three principal advantages many other obvious ones follow. The system is in fact a surface contact inclosed conduit system, and as there is no slot or other opening the conduit cannot become filled with water or dirt.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE
AMERICAN AND FOREIGN
By Carl Hering.

Dynamos, Motors and Transformers.

POLYPHASE NON-SYNCHRONOUS MOTORS. Rhodes. Lond. "Elec. Rev.," Sept. 2.—Although polyphase induction motors are self-starting, they are not all equally good in this respect, and many difficulties are to be overcome in their design. In a short theoretical deduction he shows what the starting resistance should be, but to use this requires sliding contacts. He then considers the attempt of Boucherot to attain this end without the use of a variable resistance. (Several references to descriptions of this motor have already been given in the "Digest.") Briefly described, this motor has two distinct stator windings on a common framework; one is fixed and the other is capable of being moved through a certain angle by means of a lever; there are also two motors of the squirrel cage type mounted on the same shaft. At the start the two stator windings are placed at angular distances from each other, corresponding to half a period of the current, and after the start this angle is gradually diminished until it becomes zero, at which the motor runs normally. Thus the start is effected by varying the difference of phase between two systems of polyphase circuits placed in parallel, and a high starting torque is obtained without the use of rubbing contacts. He gives the results of tests of the efficiency and power factor, both of which are high, namely about 86 per cent.; the starting torque was three times as great as the normal torque at full load, and the starting current about three times the normal current. The curves, giving the speed, efficiency and power factor, are reproduced.

SAYERS DYNAMO.—Lond. "Elec.," Sept. 2.—A brief, illustrated description of a Swedish type of this dynamo. The illustrations are for an eight-pole machine yielding 1700 amperes at 100 volts at 235 revolutions. Some years ago the improvement was made to increase the air gap toward the trailing pole-tips, so as to obtain a nearly uniform distribution of the field at full load; this also had the effect of making the reversing field more nearly proportional to the load, thus securing a nearly constant position for the brushes; the result of the experiment was most successful, and the machine ran without sparking from full down to one-tenth load.

ALTERNATORS IN PARALLEL.—Lond. "Elec. Eng.," Sept. 2.—Several answers to a question whether it is advisable to run two alternators of different design in parallel; also to the question what the smooth running of alternators in parallel chiefly depends upon. Although alternators of different design are frequently run in parallel, the practice is not to be recommended.

ROTARY CONVERTERS. De Marchena. "L'Ind. Elec.," August 25.—The continuation of his mathematical discussion (see "Digest" Sept. 3); no general conclusions appear to be drawn.

STRAIGHT VS. T TEETH.—"Amer. Elec.," Sept.—An editorial comparing the relative advantages and disadvantages and concluding that it is probable that the straight teeth will become the preferred American practice, although a method for securing the coils which is better than band wires is still desired.

ARMATURE WINDINGS. Rice. "Amer. Elec.," Sept.—In this continuation of his serial he describes the Wenstroem windings.

INDUCTION MOTOR. Wiener. "Amer. Elec.," Sept.—In this continuation of his serial he describes the armature windings of induction motors.

STEAM ALTERNATOR.—"Amer. Elec.," Sept.—An illustrated description, including a double-page plate of some large steam alternators of 2500 horse-power made in this country for a station in England.

Lights and Lighting.

ENERGY IN THE VACUUM TUBE LIGHT. Ebert. "Wied. Ann.," No. 8; abstracted in the Lond. "Elec.," Sept. 2.—In an article on alternating current discharge tubes, he gives the results of measurements of the energy consumed in the "lamp of the future." He used high-frequency currents obtained by direct transformation, and not by means of condensers; the generator was really a transformer, transforming from direct to alternating current; the alternating current was transformed to 1000 or 2000 volts by the transformer, and the current was measured by a hot wire ammeter; the voltage was measured by a Bjerknes voltmeter, consisting of an aluminum leaf hanging between two plates and at 45° with them; the alternations were 1000 per second. For a long discharge tube the following figures were obtained: 64 volts, 1.81 amperes, 116 watts for the continuous current; 33 volts, 1.05 amperes and 27 watts for the low-pressure alternating current, the phase difference being 50.5°; 2200 volts, 0.01 ampere and 20.6 watts for the high-pressure alternating current, the latter figure being the consumption in the tube at a time when it gave a perfectly steady light of about 16 candle power. The actual watts consumed compare favorably with the incandescent lamp, but not the watts consumed in the original circuit.

ECKMUEHL LIGHTHOUSE. Dary. "L'Elec.," Aug. 20.—An article giving an illustrated description of this new, large lighthouse in France; other descriptions have already been noticed.

TESTING ARC LIGHT CIRCUITS. Markland. "Elec. Eng.," Sept. 8.—The first installment of an article. He claims that the question of testing circuits while the current is on has not received the attention which it deserves, as about nine-tenths of the arc light stations rely wholly on the magneto-bell for testing. He seems to favor the use of the voltmeter instead, and in the present portion he mentions some uses to which the voltmeter may be put.

Power.

CLEES-YVERDON TRANSMISSION AND DISTRIBUTION PLANT. Laffargue. "L'Ind. Elec.," Aug. 25.—A long, illustrated description of this plant, which is said to be one of the largest and most important of those recently constructed; it has been in regular operation since December, 1896, and provides about twenty villages with light and power. A three-phase current at 5000 volts and a frequency of 50 is used; the available power is 1800 horse-power at the turbines; a waterfall of the Orbe is used; the total length of the primary circuit is 50 km; there are thirty sub-stations with a total of 1000 kw; the distribution net-work has 120 volts for the incandescent lamps or for three arc lamps in circuit; for small installations only two wires are used; the differences in the loads on the different phases do not cause any trouble in the steadiness of the lights. The number of incandescent lights is about 6500, and there are about 50 arc lamps; the chief application of the current is for motive power, as there are at present eighty motors from 0.1 to 120 horse-power of a total of 750 horse-power. The small motors are connected to the lighting circuit, while several have special transformers; there is only one motor of 45 horse-power, which is connected directly to the 5000-volt circuit. The motors all are without brushes—that is, have short-circuited armatures. Above 2 horse-power starting resistances are used, in order not to affect the lights; an illustration of one of the motors is given. The charges for current are also given, and are quite low; for a 1-hp motor the charges are $48 per year, and for a 10-hp motor at the rate of $38 per hp-year; special reduced terms are made for motors which are used only during daylight hours; in such cases there is an hour meter in series with the circuit.

POWER FOR MACHINE TOOLS AND SHAFTING. Langdon. Lond. "Elec. Rev.," Sept. 2.—A brief abstract of his recent paper before the Institute of Mech. Eng., on the electric machinery of the Midland railway. The following figures are given in the abstract. There is a shaft 98 ft. long, 2 in. in diameter, with 12 bearings, 4⅜ in. long, which drives 15 tools; ordinarily it drives 19 belts; the main shaft, without any belting, absorbed 272 watts; with the 19 belts resting on it (probably meaning running idle) the power absorbed was 518 watts, and with the countershafts added (how many is not stated in the abstract), 794 watts. To drive a 9.5-in. screw cutting lathe alone absorbed 381 watts; when cutting a gun metal bar at 1.1 oz. per minute 545 watts were used; the work done only used 164 watts, or at the rate of nearly 500 watts per oz. of metal per minute. A low-efficiency motor geared directly to the lathe used only 214 watts per oz. of metal cut per minute, showing the advantages in favor of direct gearing. A comparison is made of the power absorbed in removing metal from a lathe driven from a shaft and from a small motor; according as the metal was being removed at 1, 2 or 3 cuts, the power absorbed per oz. per minute was, with belt driving, 591, 389 and 275 watts, and with motor driving 206, 191 and 143, for exactly the same conditions as to speed and time. Thus a motor driving direct absorbed very much less power than a motor with shafting and belts, barely a fourth when the lathe was running light; this shows the economy possible with electrical driving; the difference is even greater, owing to the intermittent nature of the work, as the continuous dead load of the shafting bears a higher ratio to the live or working load than nominally appears.

TRANSMISSION SYSTEM.—Lond. "Elec. Rev.," Sept. 2.—A short article ridiculing the suggestion of Asher noticed in the "Digest" Aug. 27.

COMPRESSED AIR AND ELECTRICITY.—"Eng. News," Sept. 8.—A brief description of an interesting change which is being made in the plant of the Lassig Bridge and Iron Works, of Chicago, in which the use of line shafting will be dispensed with and all the tools will be operated by compressed air or electricity, according to which power is the best adapted for each particular purpose; the electric plant is referred to only very briefly.

CRIPPLE CREEK.—"Elec. Eng.," Sept. 8.—A brief description of the plant which has just been started and in which power is transmitted from Canon City to the Cripple Creek gold mines. (See also "Digest" Sept. 10.)

Traction.

ELECTRIC TRACTION ON STEAM ROADS IN PARIS.—"L'Ind. Elec.," Aug. 25.—A short editorial on the extension of the Orleans Railroad into the heart of Paris, on which extension electric traction is to be used, as much of the line is underground. The work on this extension is being pushed rapidly with the hope of completing it in time for the exposition of 1900. The locomotives will weigh 45 tons and have 7000 horse-power; current will be taken from the third rail; the locomotives will have four axles, each provided with a motor of 125 kilowatts; they will be able to draw normally a train of 250 tons at a speed of 50 kilometers per hour, and under certain circumstances a train of 300 tons; with this load they can start a train on a grade of 11 in a thousand. The central station will have two units of 1000 kilowatts each, and will generate three-phase currents at 5500 volts; there will be two transformer stations, in which this will be transformed into a continuous current of 550 for traction and 450 for lighting. The locomotives will be attached at the Austerlitz station, and the change will require but two minutes.

COMBINED ACCUMULATOR AND TROLLEY TRACTION. Scott. Lond. "Elec. Rev.," Sept. 2.—The beginning of an article which is intended to show that a good working compromise is possible in large cities when the accumulator and the overhead trolley systems are combined. This mixed system was first used in Hanover and Dresden; in the former the extra cost of the combined system, compared with the trolley system alone, does not exceed 0.4 cents per mile (probably car mile); the running expenses, including the driver, amounted to 4.44 cents per car mile; these figures are based on the official report of 1896; there is sufficient evidence that the system has been found very remunerative in Hanover, and can be honestly pronounced to be a success. In none of the continental systems are the batteries moved about the way they are in Birmingham; in Berlin this system, as also the combined trolley and conduit system, is used, and the authorities appear to prefer the former, as the streets are not disturbed and the trouble with the drainage of the conduits is eliminated. He then gives a description of the latest of these plants in Paris.

HOLMENKOLLEN MOUNTAIN RAILWAY. Hoffmann. "Elek. Zeit.," Sept. 1.—A long, illustrated description of this line, running out from Christiania, Norway; it passes through a very hilly region, and is largely a tourists' line. The difficulties involved in curves and grades were quite great, 40 per cent. of the line being straight and 60 per cent. on curves; the maximum grade is 1 in 25 and the mean 1 in 27, the total rise being 192 metres and the total length 6.59 km. The current is obtained from the power house of another line, the voltage being 530; parallel to the dynamo is a battery of accumulators located 3.5 km from the power house; it contains 250 cells, and can be discharged in from one to three hours; ordinarily it is simply connected in parallel, but for complete charging it is divided into three groups, each two of which are charged in series; there are two meters in circuit, each running in only one direction, so that the charging and discharging currents are both measured; the proportions are such that the state of charge at the beginning and end of a day's operation is the same; the difference in the voltage of a battery at charging and discharging is 30 to 40 volts. Each car has two motors of 25 horse-power each; the controller diagrams are reproduced.

STATIONARY ACCUMULATORS IN POWER HOUSES. De Waal. "L'Elec.," Aug. 27.—An abstract in French of the paper by Schroeder, which was noticed in the "Digest" last year.

MEASURING THE POWER FOR PROPELLING SHIPS.—"El'ty," Sept. 14.—A short editorial on the experimental tank which is being built by the Navy Department in Washington, the object of which is to measure the speed of ships with the aid of models. It is expected that the tank will be completed by October 1; the tank is 370 ft. long and 40 ft. wide; the model ships will be drawn by means of a towing carriage driven electrically at speeds from the slowest to 2000 ft. per minute; the weight of this carriage will be 45,000 pounds, and it will have four motors, to be operated at 250 volts; the controller will give 45 different speeds.

CONTROLLER CONNECTIONS.—"Amer. Elec.," Sept.—Four diagrams, showing the connections in the controllers of the General Electric, the Westinghouse, the Walker and the Johnson companies.

CAR WIRING. Monroe. "Amer. Elec,," Sept.—A short article, giving practical hints concerning the details in car wiring.

CRIPPLE CREEK. Hardesty. "Eng. News," Sept. 8.—A brief, illustrated description of this electric railway, which is said to be the highest in the world, connecting Cripple Creek and Victor and running directly over the top of a mountain.

CLEVELAND. Fairchild. "Elec. Eng.," Sept. 8.—The first part of an article in which he gives illustrated descriptions of the five long, electric, high-speed railways radiating from Cleveland; two of them are described in the present installment.

BOSTON. Weller. "Elec. Eng.," Sept. 8.—An illustrated description of the Harvard power station of the Boston Elevated Railway Company.

Installations, Systems and Appliances.

ACCESSORIES FOR 250-VOLT INSTALLATIONS. Passavant. "Elek. Zeit.," Sept. 1.—A reprint of his paper read before the annual meeting of the Union of German Electricians. It is a mere summary, as it is practically the same as the paper which was noticed in the "Digest" July 30.

WATER POWER INSTALLATIONS IN THE FRENCH ALPS.—"Elek Zeit.," Sept. 1.—An abstract of a short article noticed in the "Digest" Aug. 27.

ELECTRICITY IN SPAIN.—"L'Elec.," Aug. 20.—An abstract in French of the German article noticed in the "Digest" May 28.

DETROIT.—"Eng. News," Sept. 8.—A long analysis of the third annual report for this municipal plant, this city having made the largest venture in a municipal electric lighting system of any city in the United States. A table is given showing the average cost of the arc street lighting in each State and in each of the principal cities in the United States; comparing the Detroit figures with the average for 1045 plants included in the first table, it is shown that in Detroit the hours per lamp were greater, the cost for coal less, the cost per lamp per year less, and the cost per lamp per hour considerably less than the average of all the stations reporting. An extract of the original report was published in The Electrical World Aug. 13.

Wires, Wiring and Conduits.

COST OF COPPER, ALUMINUM AND IRON CONDUCTORS. Kershaw. Lond. "Elec. Rev.," Sept. 2.—A short article in which he calculates the relative costs of copper, aluminum and iron when used as electrical conductors; first, on the basis of the data in Hunt's recent (American) paper and then based on prices taken from current price lists. He obtains a simple algebraic expression in which he substitutes the values used by Hunt and obtains 101 to 100 as the relative cost of copper and aluminum wire of equal lengths and equal electrical resistance; this agrees closely with Hunt's figures. Substituting the figures taken from current price lists, in which the price of copper is taken as nearly 12 cents per pound instead of 14, as assumed by Hunt, and that of aluminum as nearly 32 cents, instead of 29, and for its conductivity 59, instead of 63, he obtains the ratio 100 to 135; he assumes 99 per cent. aluminum; thus aluminum is 1⅓ times as costly as copper. The cost of converting the ingot metal into wire will probably be about the same in the two cases. He doubts whether any company will ever be able to produce 100 per cent. aluminum in wire at 29 cents per pound. He then makes a similar comparison between iron and copper, obtaining the ratio 278 to 100, assuming a conductivity for iron of 16.4 Matthiessen standard at a price of about $18 per ton; it is therefore by far the cheapest metal for electrical transmission, and although its weight, compared with copper and aluminum, prevents its being used for overhead lines, there seems to be no reason why it should not be used for underground conductors or in factories where the lightness of the conductor is of secondary importance, and where the current is a low potential one; for high potentials the difficulties of insulation make the iron more costly. In conclusion he gives a summary of these figures, showing the relative cost of conductors of equal length and equal electrical resistance; they are as follows: Aluminum, 99 per cent., at present market prices, 375; copper, electrolytic, at present market prices, 278; aluminum, 100 per cent., at A. E. Hunt's value, 275; iron, at present market prices, plus 28 per cent. for rolling, 100.

CALCULATING THE WIRE FOR THREE-PHASE CIRCUITS.—"Amer. Elec.," Sept.—A note giving a convenient rule for calculating the proper size of wire for a three-phase power transmission. The ratio of the amounts of copper used for equal power and voltage is 100 for the single-phase and 75 for the three-phase system; for the single-phase system the calculation is the same as for the direct current with two wires; if the proper size of wire is calculated for direct currents and the required millage divided by two, it will give the proper size of wire for the three-phase circuit, because 75 per cent. of the volume of two wires of a given size is equal to the volume of three wires of half that size, the lengths being equal.

Electro-Physics and Magnetism.

VOLTAGE CURVES IN DISCONNECTING INDUCTIVE RESISTANCES. Natalis. "Elek. Zeit.," Sept. 1.—In disconnecting an inductive resistance the lines of force which have been linked with the windings will pass out, thus producing an e. m. f., and the voltage arising at the ends of the coil is of opposite sign; the amount of this voltage is equal to the product of the number of windings, and the speed with which the lines of force move; there are several things which oppose this change—the Foucault currents in the iron, the hysteresis and the sparking or arcing current; as the calculation of this voltage is, therefore, not practicable, he made experiments to determine it, and in the present paper he describes the methods and the results. He used the well-known revolving Joubert disc, and determined the voltage curves for a coil with many windings, and then for one with few windings, in each case with or without a solid iron core or a bundle of wires, and finally for the field circuit of a small dynamo. The curves show the observed voltage as a function of the time. The tests cease just where they begin to be of practical interest to the constructor, but they include some interesting results. The speed of revolution of the disc and the nature of the contact surfaces have a very great effect on the voltage curve; the more rapid and perfect the inter-

ruption, the higher the voltage. Contrary to expectations, very little difference was found when the solid iron core was used in place of one made of a bundle of wires. All the curves have a similar form; at the moment of the opening of the circuit the voltage changes its sign; it drops from the original positive value to a negative maximum, which is generally considerably greater than the original positive value; at this maximum negative value the curves show a characteristic sharp point; it is this negative maximum which is of special interest, as it is the one to which the insulation of coils is subjected. The values so determined required some correction, as the galvanometer gives only the mean value; he shows how the maximum may be calculated. Measurements were also made when the break was shunted with a non-inductive resistance. In one of the cases in which iron was used the voltage increased 7.8-fold, while in another it was 3.5-fold, the difference being due to the difference in contact at the break, which was more rapid in the first case; without an iron core the increase was 5.13-fold, a result which is surprising because the energy stored in the iron was about 18.6 times as great, and it shows the lines of force in the coil without iron pass out about 18.6 times as rapidly. In another set of coils a very low voltage—1.23—was used, the speed of interruption of which was much greater, as the sparking current did not continue so long; the induced voltage at breaking was, therefore, relatively much higher, it being 15.9-fold in one case, 37.3 in another, and in still another, when the coil had no iron core, it was as high as 73.3-fold; special attention is called to the great increase in voltage when there is no iron in the coils. Another curve shows the effect of an inductionless shunt to the break. Still another shows the voltage curve when the coil is switched into circuit; the voltage rises, owing to self-induction, a little above the steady voltage, after which it falls down to that value. The voltages may be even still higher than those which he obtained, as he found that he could in certain cases draw sparks from the circuits to the ground. The results of his experiments show that very high voltages may be obtained in breaking such circuits, and they may easily reach ten times the original voltage; the breaking spark forms a natural protection, and takes care of part of the energy set free; other artificial means are the use of carbon contacts, which prolong the duration of the spark, or shunts, which should be as free from induction as possible, like carbon or liquid resistances. Suddenly opening the circuit of a machine with the aid of an apparatus for blowing out the spark can become very dangerous when that is the only circuit connected to the dynamo.

EXTRA CURRENT AT BREAKING. Arons. "Wied. Ann.," 63, p. 177; abstracted in "Elek. Zeit., Sept. 1.—An abstract of the article noticed in the "Digest" Aug. 27.

CURRENT RUSHES IN TRANSFORMERS. Hay. Lond. "Elec. Rev.," Sept. 2.—The conclusion of his article (see "Digest" last week). In the present portion he gives the results of his experimental investigations, which fully confirm the theoretical deductions to which he arrived. The curves are reproduced, and show the gradual subsidence of the abnormal waves as well as the inequality of successive half waves of counter e. m. f.; he also shows the enormous importance of the initial magnetic induction in determining the current rush. He concludes that the generally accepted notions regarding the phenomenon of initial current rushes appear to be of the vaguest and most unsatisfactory kind; it is repeatedly stated that transformers are liable to break down at the instant of connecting, owing to the current rush, the argument advanced being about as follows: Assuming that the current rush takes place, the magnetic induction will, during the initial quarter wave of current, be carried far above its normal maximum value; during the next half wave the abnormal induction is removed and a reversal to the normal maximum takes place, thus developing an abnormally high e. m. f., which breaks down the insulation. His experimental results show how utterly fallacious this reasoning is; they show that it requires a large number of waves to wipe out the abnormally high magnetic flux, the core settling down gradually into its normal cycle of magnetization; hence even when the current rush is exceptionally large there is no corresponding rise of voltage. There is another consideration, which seems to have been overlooked by others—namely, that if there is a high voltage produced, how is it that only the transformer producing it suffers, as the disturbance should spread through the entire network? Where breakdowns have occurred it is either due to a defect in the insulation or, as suggested by Swinburne, by the high induced voltage at the instant of switching off instead of on; the fault so developed would remain unnoticed until the next time of switching on. His deductions show that the phenomenon of current rushes is capable of being explained in a simple and straightforward manner; also that the alleged breaking down of transformers at the instant of connection is a scientific myth for which there is neither theoretical nor experimental foundation.

PARALLEL AND SERIES CONNECTION OF CURRENTS OF DIFFERENT WAVE FORMS. Roesseler. "Elek. Zeit.," Sept. 1.—When there are several alternating currents in parallel the effective value of the combined current and its phase are readily determined graphically by means of the well-known diagram, when the curves of the currents are sinusoidal; this may also be done when the currents are connected in series. In the present article he endeavored to find whether this method is also correct when the curves are not sinusoidal; the question is of importance, as in the usual parallel connections the current curves often differ greatly from the sine form. The conception of a phase shifting ceases when the various curves differ from each other; in such cases another conception of the phase angle can be used; the angle, in such cases, may be assumed to be that whose cosine, multiplied by the current, gives the effective value of the latter—that is, the "watt component," while the original current, multiplied by the sine of that angle, gives the wattless component. Instead of the usual graphical diagram for sinusoidal currents, the total current might also be found by separating each of the currents into its watt component and its wattless component, adding each separately, the two resulting sums being then the two components of the corresponding total current; in this way there is no need of the conception of a phase shifting; with his method of combining them it can then be shown whether the method can be used for curves of any form. On these lines he finds that the watt or energy component of the combined current is equal to the sum of those of the single currents; but this is not true in general for the wattless components. The same conclusions apply to the series connection of separate currents. He shows further that the magnetizing component of the total current in the parallel connection of alternating apparatus is not in general equal to the sum of the magnetizing components of the separate currents. In an appendix he gives a general proof of the statement that for all voltage and current curves the mean value of the energy is less than, or equal to, the product of the effective values of the voltage and the current.

EFFECT OF FORM OF ALTERNATING-CURRENT CURVE. Webber. "Wied. Ann.," 63, page 366; abstracted in "L'Eclairage Elec.," August 13.—It is generally supposed in the methods of measuring the capacity and coefficients of induction by alternating currents that the wave form is strictly sinusoidal, but this condition is rarely satisfied. In the present article he shows how the formulas should be modified accordingly.

LAW OF INDUCTION. Feldmann. "Elek. Zeit.," Sept. 1.—A communication in which he cites some cases to which the new law suggested by Breslauer (see "Digest" Aug. 20) does not apply, and it is, therefore, not satisfactory. He concludes that the conception of e. m. f. by the cutting of lines of force is the simplest one and is applicable to all possible cases; it may, therefore, be considered as the fundamental form of the law; the conception, based on the increase or diminution of the lines of force inclosed by a circuit, is a special case of this fundamental law.

CONSERVATION OF ENERGY. Tauleigne. "Cosmos," June 18.—The first part of an article on the principle of the conservation of energy as applied to electrical phenomena.

POTENTIAL MATTER. Schuster. Lond. "Elec.," Aug. 26; reprinted from "Nature."—A short article called "A Holiday Dream," which is of a speculative nature, discussing the subject of matter and anti-matter; it is general in character and has no special reference to electricity.

VAPORIZATION OF THIN WIRES. Toepler. "Wied. Ann.," No. 8; noticed briefly in the Lond. "Elec.," Sept. 2.—Descriptions of experiments made with his 60-plate influence machine, showing the stratification of the vapor of a thin wire when it was disintegrated by a strong discharge; when the vapor is caught on a glass plate held near the wire the deposit is beautifully stratified.

CONTACT RESISTANCE. Branly. "L'Elec.," Aug. 27.—A reprint of his Academy paper on the resistance of contact of discs of the same metal, which was noticed in the "Digest" Aug. 27.

ELECTRIC WAVES. Bose. Lond. "Elec.," Sept. 2.—A reprint of a Royal Society paper on the rotation of the plane of polarization of electric waves by a twisted structure.

HERTZIAN OSCILLATIONS. Ekstroem. "Wied. Ann.," 64, page 315; abstracted in "L'Eclairage Elec.," August 6.—He studied Hertzian oscillations by the stationary waves in wires.

HERTZIAN WAVES. Waitz. "Wied. Ann.," 63, page 234; abstracted in "L'Eclairage Elec.," August 6.—He measured the unequal absorption of the electric and the magnetic vibrations of Hertzian waves.

ELECTRIC OSCILLATIONS. Motte. "Wied. Ann.," April; noticed in "L'Eclairage Elec.," August 13.—An article on the higher order of electric oscillations.

DIMINUTION OF RESISTANCE BY OSCILLATIONS. Auerbach. "Wied. Ann.," March; abstracted briefly in "L'Eclairage Elec.," August 13.—He investigated the diminution of the resistance produced by electric and acoustic oscillations.

DAMPING OF ELECTRIC WAVES. Planck. "Wied. Ann.," 63, page 419; abstracted in "L'Eclairage Elec.," August 6.—He discusses the damping of the radiation of energy in the space surrounding an oscillator.

DAMPING OF RESONATORS. Lagergren. "Wied. Ann.," 64, page 290; abstracted in "L'Eclairage Elec.," August 6.

DIELECTRIC PROPERTIES OF ICE. Abegg. "Wied. Ann.," 65, page 229; abstracted in "L'Eclairage Elec.," August 6.

RESEARCHES WITH NICKEL AND ITS ALLOYS. Guillaume. "L'Eclairage Elec.," August 13.—A long abstract of a pamphlet recently published containing the results of his very elaborate researches with the properties of nickel and its alloys; the abstract is quite long, and is followed by an abstract of a paper by Dumont on researches made with the magnetic properties of nickel steels, under the direction of Guillaume. Portions of the descriptions of Guillaume's researches have already been referred to in that journal, and were duly noticed in the "Digest." The electric and magnetic properties form only a portion of the properties investigated. Among other things he found that alloys containing

from 0 to 25 per cent. of nickel are irreversible—that is, at the same temperature they can exist in two essentially different states, according to the cycle of the previous temperatures; above about 25 per cent. the alloys are reversible. He gives a formula for the temperature at which the magnetism is lost, as a function of the percentage of nickel in the alloy. The effect of an addition of chromium to the non-reversible alloys is to considerably lower the temperature of transformation. The specific electric resistance of nickel steels is high, and it differs little in the various alloys; for those investigated it was between 80 and 90 microhm centimetres; he determined the resistance for a large number of temperatures between 20° and 250°, and many different alloys; it was not possible to find a relation between the variations of the resistance and the other phenomena observed for these alloys. He discusses the subject theoretically and suggests some applications of the properties of these alloys. In the paper by Dumont the method of measurement is described with the aid of a diagram of the connections, and the results are given in curves. For the reversible alloys at different temperatures he found the following law: "At equal distances from the point of magnetic transformation all the reversible alloys have the same permeability." Also "the magnetic permeability increases with the percentage of nickel." The results obtained with the irreversible alloys and with the addition of chromium are also briefly referred to in the abstract. He also determined the hysteresis curves, and found that for annealed alloys they approach closely to the cycles for soft iron.

THERMOMAGNETIC PROPERTIES OF BISMUTH. Everdingen. "Proc. Akad. Amsterdam," August 9; abstracted in Lond. "Elec.," August 26.—Riecke concluded from experiments that the thermomagnetic differences of temperature is zero in bismuth; the present author subjects this conclusion to a detailed criticism. The two surfaces of a plate of bismuth were kept at different temperatures and connected through a galvanometer, while the magnetic field to which the plate was exposed was reversed; a considerable difference was observed in pure bismuth. There is an undoubted difference of conductivity produced in bismuth by exposure to a magnetic field, but the difference in electrical conductivity is larger than in the thermo-conductivity; Riecke's theory wrongly ascribes the whole conduction of heat to the charged particles.

THERMO-MAGNETIC PROPERTIES OF BISMUTH. Defregger. "Wied. Ann.," No. 63, page 97; abstracted in "L'Eclairage Elec.," August 6.—He investigated this property in the longitudinal direction, subjecting the plate of bismuth to a magnetic field. He showed that the action of the magnetic field on the thermo-electric properties of bismuth varies with the direction of the field.

THEORY OF ZEEMAN EFFECT. Lorentz. "Proc. Akad. Amsterdam," August 9; abstracted briefly in Lond. "Elec.," August 26.—An expansion of his theory in order to explain some new phenomena of the multiplication of spectrum lines; he assumes that a molecule may have a number of arbitrarily distributed electrical charges.

ZEEMAN EFFECT. Zeeman. "Proc. Akad. Amsterdam," August 9; abstracted in Lond. "Elec.," August 26.—According to theory a certain symmetrical effect might be expected; experiments made by him to determine this, however, failed to show any such want of symmetry.

EFFECT OF VIBRATIONS ON MAGNETISM. Fromme. "Wied. Ann.," 63, p. 314; abstracted in the "Elek. Zeit.," Sept. 1.—He determined whether electrical oscillations in the neighborhood of the iron changed the magnetic condition of it.

MAGNETIC CHARTS. Mathias. "Jour. de Physique," Aug.; abstracted briefly in Lond. "Elec.," Sept. 2.—He recommends a new kind of magnetic chart for France, on which are to be entered, not the magnetic elements for the time being, but the difference between the local elements and those of the central observatory; as a result the curves obtained will be practically stationary for a number of years.

Electro-Chemistry and Batteries.

ASSAYING GOLD. Bock. "Chemiker Zeit.," Vol. 22, p. 358; abstracted in Lond. "Elec. Rev.," Sept. 2.—A description of a semi-electrolytic process. He found that by using water as an electrolyte, only faintly acidified with nitric acid, the electrolyte does not become cloudy, as it does when strong nitric acid is used, and the weight of the gold remains unchanged, while the silver and all other soluble metals in the anode, except lead, are deposited on the cathode or dissolved; his process is based on this phenomenon, and gives very accurate results, as is shown by an example. The process is cheaper and gives an easier way of preparing samples of pure gold.

ELECTROMETALLURGY. Moissan. "Zeit. fuer Elek.," August 14.—A brief description of his recent Congress paper on the preparation and properties of pure and crystallized calcium; he describes a method of preparing this electrolytically from fused calcium iodide. Two other papers by the same author are also noticed briefly, one on the electrolytic preparation of glucinum and its alloys in the electric furnace, another on the production of some double carbides and a carbide of tungsten.

ELECTROLYTIC CONSTRUCTION OF METALLIC VESSELS. Englehardt. "Zeit. fuer Elek.," August 14.—An abstract of a recent Chemical Congress paper. He mentions the Nussbaum process, in which the mould is so constructed that water, under pressure, can be forced between the deposited metal and the mould, thus stripping one from the other; the advantage of the electrolytic method of making such cooking utensils is that the metal may be made any desired thickness at any desired places.

RAPID DEPOSITS.—"Zeit. fuer Elek.," August 14.—A note stating that according to an English patent to Swan the rapidity of the electrolytic deposition of copper may be greatly increased if the electrolyte is kept in continuous circulation. The current density was increased to 20 amperes per square decimetre, thus enabling an electrotype to be produced in one hour instead of six hours, as usual.

PASSIVE STATE OF IRON. Houllevigue. "Jour. de Physique," Aug.; abstracted briefly, with the curve, in Lond. "Elec.," Sept. 2.—When a bar of iron is rendered passive by concentrated acid and is plunged into nitric acid of a certain density there is a certain temperature which forms the transition point between the stable and the unstable condition; he determined the condition governing this stability for various samples of iron, densities and temperatures; the stable passive state has an upper and lower temperature limit.

SEPARATION OF CHROMIUM, BROMIUM AND IODINE. Specketer. Lond. "Elec. Rev.," Sept. 2.—A brief abstract of the article noticed in the "Digest" July 2.

ELECTROLYTIC THEORIES. Edser. "Elec. Eng.," Sept. 2.—In this continuation of his serial he discusses some forms of cells capable of producing current, but in which no chemical reactions take place. In one of these there are two electrodes of copper, one above the other, the lower being in a denser solution of copper sulphate; in another the two electrodes are zinc amalgam of different concentrations.

AMMONIUM CHLORIDE ACCUMULATOR. Stine. "Amer. Elec.," Sept.—A short article on this accumulator, made with carbon plates, with which he made experiments as early as 1891, thus anticipating the invention of the same battery by Sandaran. The plates were made of carbon dust saturated with a 20 per cent. solution of chloride of ammonia; the cell was capable of receiving a considerable charge without gasing; the voltage immediately after charging was 1.7, but always fell to less than 1 volt on standing twelve hours; the gas which is given off is extremely offensive; the ampere-hour capacity and the watt efficiency were low; the cells are inexpensive and can no doubt be made much lighter for a given capacity than lead storage batteries.

Units, Measurements and Instruments.

CAPILLARY ELECTROMETER. Burgess. Lond. "Elec. Rev.," Sept. 2.—A short communication in reply to a recent criticism in that journal. He points out the advantages which he found in using the electrometer for insulation measurements, claiming it to be superior to the galvanometer in several ways. The fact that the zero method is required is no disadvantage; the use of a high graphite resistance of about 1 megohm is entirely practical, as he found it very satisfactory in measuring values as high as 30,000 megohms; moreover, a dynamo current may be substituted for the testing battery, and this is better, as cables should be tested at a pressure at least as great as that with which they are intended to be used.

COMPOUND QUADRANT ELECTROMETER. Haga. "Proc. Akad. Amsterdam," August 9; abstracted briefly in Lond. "Elec.," August 26.—He devised a five-cell apparatus, in which a hollow copper cylinder is made to vibrate in a magnetic field as a damper. The sensitiveness is very great, but depends largely on the suspension fibre; with a certain quartz fibre 17 cm long a single Clark cell gave a displacement of 12 m (presumably mm) at a distance of 2 m, the needles being charged to 180 volts.

NEW FORM OF CAPILLARY ELECTROMETER. Vanni. "Nuovo Cimento," June; abstracted briefly, with the illustration, in the Lond. "Elec.," August 26.—He designed a form of instrument adapted for school use. It consists of a tank containing mercury and sulphuric acid, into which dips a vertical capillary tube, which does not touch the mercury; this is made one pole, while the mercury at the bottom of the tank is the other; the capillary tube is filled with mercury. A few ten-thousandths of a volt can be readily seen when this is projected on a screen.

ELECTROMETER FOR OSCILLATIONS. Toepler. "L'Eclairage Elec.," August 6; abstracted, with the illustration, from the "Wied. Ann.," December.—A description of a modified electrometer for studying electrical oscillations.

SHUNTED ELECTRO-DYNAMOMETER. Wien. "Wied. Ann.," 63, p. 390; abstracted in the "Elek. Zeit.," Sept. 1.—In order to use the same instrument for currents of greatly different capacity, it is desirable to shunt an electro-dynamometer, as is done with a galvanometer. In the present article he shows how this can be done. The self-inductions of the electro-dynamometer and the shunt should be in the same proportion as their resistances; this proportion is determined by inserting them in the branches of a Wheatstone bridge. There should be no iron, steel or large masses of metal in or near the movable coil.

CONDENSERS FOR LARGE CURRENTS. Boucherot. "Elek. Zeit.," Sept. 1.—A long abstract of the article noticed in the "Digest" March 12 and April 16.

LEYDEN JAR OF VARIABLE CAPACITY. Leduc. "L'Eclairage Elec.," Aug. 20.—An abstract of a French A. A. S. paper. He described a Leyden jar, the capacity of which is varied

by altering the distances between the coatings. In using influence machines for the production of X-rays the Leyden jars used are generally of too great a capacity; for these purposes the present adjustable jar is especially adapted. A machine with two plates of 55 to 60 cm diameter will easily give the same result as a coil giving a 15 to 20 cm spark, and has the great advantage that the tubes are more easily handled.

INDUCTION STANDARD. Froehlich. "Wied. Ann.," 63, p. 142; abstracted in the "Elek. Zeit.," Sept. 1.—A description of a standard self-induction coil, the value of which could be calculated from the geometric proportions. It was wound on a core of marble, and there was only a single layer of very thin wire. The comparisons with other coils showed a very good agreement between the calculated and the observed values, the largest difference being less than 0.2 per cent.

WIMSHURST MACHINE. Leduc. "L'Eclairage Elec.," Aug. 20.—An abstract of a paper read before the French A. A. S. The theories of this machine, which credit the combs with the function of starting the machine, are incorrect, as they do not agree with facts; these collectors have nothing to do with the starting, their only function being to gather up the charges produced. He studied the action of such a machine in the dark, and from these observations he shows how the machine may be considered to operate. From this he found that the output can be increased, as also to a slight degree the voltage, by replacing the combs of the collectors with brushes sliding on the sectors, which are then much more completely discharged.

MEASURING THE EFFICIENCY OF A DYNAMO. Taeuber. "Elek. Zeit.," Sept. 1.—A description of a test made to determine the electrical losses in a 220-kw three-phase generator with a vertical axis, coupled with a turbine; the object of determining the losses was to find the efficiency. Under the circumstances the dynamo could not be uncoupled from the turbine, and, moreover, the design was such that the water pressure in the turbine relieved the pressure on the bearings; the generator could not, therefore, be run without also running the turbine. A motor whose efficiency was known or determined was belted to the dynamo shaft, and the current required for this motor was measured; a diagram of the connections is given. The turbine was first brought to normal speed by means of water power, after which the water supply was kept quite constant and the turbine, therefore, generated the power to turn itself, the dynamo and all the friction and air losses in the dynamo and the small motor; the field was then excited, which reduced the speed; current was then supplied to the motor to bring the speed back to the normal and the electrical energy was measured; the results are given in curves, which give one of the factors in determining the efficiency. Similar tests were then made to determine the copper losses, and the Foucault currents caused by the armature current, the three-phase generator being short-circuited through three amperemeters; this gives the other factor for calculating the efficiency. The motor was then uncoupled, and the energy measured to bring it up to the same speed as it had in the tests. Although a change of speed could not be observed for a less difference of energy than 1000 watts the results are not as inaccurate as it might at first appear; the losses of about 5 per cent. were determined with an accuracy of about 8 per cent., so that the efficiency of the generator was determined to within less than half of one per cent.

USE OF QUANTITY METERS. Hospitalier. "L'Ind. Elec.," Aug. 25.—A short article in which he calls attention to the advantages of quantity meters instead of the usual energy meters, under certain circumstances. In installations where the voltage is practically constant the advantage is in favor of the quantity meter, as it does not involve the loss of the shunt current, which at 5 watts during 8760 hours in the year represents 44 kw-hours of energy; this is doubled in 220-volt installations. For small powers or small consumers it is, therefore, much better to use the quantity meter. These he then divided into electrochemical and mechanical; the former have been gradually abandoned and have the disadvantages that they absorb from two to three volts for a current of 5 amperes; he does not think they will ever be very satisfactory. Among the mechanical meters he believes that the motor meters are incomparably superior to those involving clockwork. In the class of motor meters two important inventions have recently been made, one a meter by Blondlot, described recently before the French Academy (see "Digest" Aug. 6 and 20), and another by O'Keenan; descriptions of both of these are promised in that journal.

COMPARISON OF LOW RESISTANCES. Callendar. Lond. "Elec.," Sept. 2.—A reply to the recent communication of Fisher (see "Digest" last week). He points out the importance of taking due precautions to avoid or eliminate thermo-electric effects in comparing low resistances; if such a thermo-electric voltage exists the error will be the same, whether the measurement is made by a potentiometer or the bridge method; their effects may be of less importance in current measurement with the ordinary potentiometer than they are in the comparison of very low resistances by any of the methods under discussion; he illustrates this with numerical examples. It is in the testing of ammeter shunts, such as are used on switchboards, that errors due to thermal effects begin to be of great importance.

MEASURING THE LENGTH OF THE ARC.—Lond. "Elec. Eng.," Sept. 2.—Two brief descriptions of how the distances between the carbons of an ordinary arc and of the inclosed arc are measured; in both the usual lens and screen method is used.

LOW TEMPERATURE SCALES. Dickson. Lond. "Elec.," Sept. 2.—A reprint of an article from the "Phil. Mag.," noticed in the "Digest" July 2.

APPARATUS FOR ILLUSTRATING CHANGE OF PHASE. Moreland. "Elec. Eng.," Sept. 8.—An abstract of his A. A. A. S. paper. He describes an apparatus, which consists of a divided circuit, each branch of which is a conductor stretched between the poles of an electro-magnet with means for adjusting its tension so that it may be made to vibrate in accordance with the period of the alternating current. A small mirror is attached to one end of each of the conductors, and they are placed at right angles to each other, so that a beam of light is reflected successively from the two mirrors, one conductor being horizontal and the other vertical. If only one vibrates a horizontal or vertical beam of light will be seen; if both vibrate in phase, there will be an inclined band formed; if an iron core is introduced into one branch of the circuit the phase will lag, and the resulting figure produced will be an ellipse; a similar result will be obtained with a condenser in one of the circuits, but the movement of the spot of light will be in the opposite direction. In order to show the direction of motion the beam of light is passed through a small hole and then through a slit attached to a tuning fork, so that the light can pass on the mirrors only in the middle position of the tuning fork; the time of vibration of the tuning fork is adjusted so that it makes one vibration, while the conductors make two, so that instead of a complete ellipse one sees only a stationary arc; if the time of the vibration of the fork is then slightly increased the arc will move around slowly in the direction in which the spot actually travels.

STANDARDS. Carhart. "West Elec.," Sept. 10, and "Science," Sept. 9.—A reprint of the report on standards of measurements by a committee appointed by the A. A. A. S. The determination of the mechanical equivalent of heat by the electrical method gives larger values than Rowland's result, and it thus created a demand for the redetermination of the ampere in terms of the electrochemical equivalent of silver; this redetermination was made for the committee and is described in a paper to that association by Guthe; the determination was made with a specially constructed electro-dynamometer of large dimensions, and the value found was 0.0011192 gram per ampere per second in a used solution of neutral silver nitrate made of 15 parts by weight of the silver salt to 85 parts of distilled water; this exceeds Lord Rayleigh's value by about one-ninth of 1 per cent., and would cause the discrepancy in the mechanical equivalent of heat to disappear. The corresponding change in the e. m. f. of the Clark cell will be from 1.4342 to 1.4327 at 15° C. Kahle obtained the value 0.0011182 by using a fresh solution, while Pellat and Potier obtained the same value as Guthe.

SHUNTS FOR INSTRUMENTS.—"Amer. Elec.," Sept.—An illustrated description of a simple, convenient and accurate method of making low resistance shunts of a certain ratio to that of the indicating instrument. A fine wire is wound with the desired number of windings over a plate of mica, the edges of which are then clamped between suitable terminals, the wires being then in multiple arc.

Telegraphy, Telephony and Signals.

ACCUMULATOR INSTALLATION FOR TELEGRAPHY. Tribelhorn. "Elek. Zeit.," August 25.—A brief, illustrated description of the plant at the main telegraph station at Buenos Ayres. The plant is for seventy lines and twenty local circuits. A diagram shows the complete connections; there are two batteries made up of groups, of 50 volts each; for the lower voltages there are two sets of batteries in multiple; the charging takes place while they are in action, the dynamo being driven by a gas engine. For the local circuit there is a separate set of batteries in two groups of 25 volts each.

TELEPHONE SYSTEM. Montillot. "L'Elec.," Aug. 20 and 27.—An illustrated description of the system used by the Omnibus Company in Paris; a self-adjusting pendulum call is used, and is described with the aid of a good illustration.

AUTOMATIC TELEPHONE EXCHANGE.—Lond. "Elec. Rev.," Sept. 2.—A brief, illustrated description of the Direct Telephone Exchange Syndicate's system, which has already been referred to in the "Digest."

LUMINOUS SIGNAL SWITCHBOARD. Miller. "Amer. Elec.," Sept.—In this continuation of his serial he gives an illustrated description of such switchboards, which have now come into general use in American telephone installations.

SIGNALING IN THE GERMAN NAVY. Pontifex. "Elec. Rev.," Sept. 14.—A reprint of the article noticed in the "Digest" last week.

LODGE'S SYSTEM OF WIRELESS TELEGRAPHY.—"Elec. Rev." and "El'ty," Sept. 7.—A reprint of the article abstracted in the "Digest" Sept. 3.

Miscellaneous.

ELECTRIC DEVICE FOR ENABLING THE BLIND TO READ. Turine. "L'Eclairage Elec.," August 6.—A short article suggesting an apparatus by means of which the blind could be enabled to read printed or written characters. Five small points like the teeth of a comb are to be moved along the line at a uniform

velocity, the space included between the two outside, corresponding to the height of the letters; suppose that each time one of these teeth passes from white to black—that is, cuts the line forming a letter—a momentary sound is produced, the pitch of which is different for each of the teeth; the succession of these acoustic signals would then be characteristic of the letter over which the teeth have moved. The duration of each signal is an indication of the time during which the point passes over the line and the height of the note corresponds to the distance of that point from the base line. He suggests making these points of selenium, which will cause the current to be varied as the intensity of the light falling on it varies; different devices could be used for transforming these variations into acoustic signals, one form of which he describes. This system has the advantage over the phonograph, in that the reproduction of the phonograph cylinders is an expensive and slow process, and it would require many cylinders to include the matter in a book.

ELECTRICAL INDUSTRIES IN BERLIN.—"Elek. Zeit.," August 25.—Reports from the largest electrical manufacturers in Berlin concerning the present development of the industry.

BIOGRAPHICAL.—The English journals, Sept. 2, contain biographical notices of the late Dr. John Hopkinson. The Lond. "Elec. Rev." contains a good full-page portrait; also a tribute to him from one of his associates. The Lond. "Elec. Eng." contains the best account of the sad accident.

MAGNETIC SURVEYING FOR IRON ORES. Nordenstroem. Lond. "Elec. Eng.," Sept. 2.—A reprint of an illustrated paper read before the Iron and Steel Institute in Stockholm. In Sweden magnetic instruments have long been employed on a large scale for discovering iron ores, and the instruments have reached great perfection.

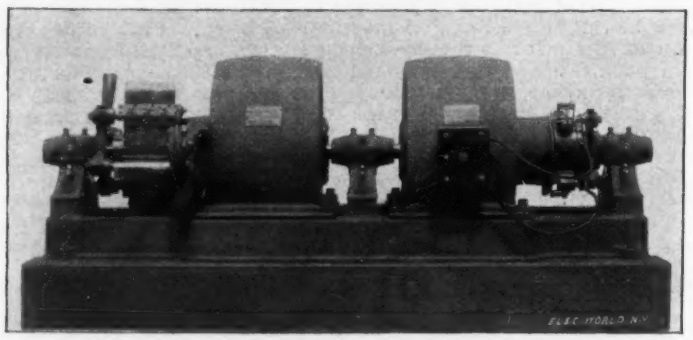
CONSTRUCTION WORKS.—Lond. "Elec.," Sept. 2.—A brief, illustrated description of the works of the Davy Company.

FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. Blondin. "L'Eclairage Elec.," Aug. 20.—Abstracts of the electrical papers read at the recent congress at Nantes, Aug. 4 to 11; these papers are noticed in the "Digest" under their respective headings. Next year the meeting will be at Boulogne and in 1900 it will be in Paris.

Motor-Generator for Electroplating.

The machine shown in the accompanying illustration is a motor-generator designed by the Jantz & Leist Electric Company, 222 East Ninth Street, Cincinnati, Ohio, for electrotypers. It is of the multipolar type, with spherical cast yoke, into which are set laminated soft wrought-iron pole pieces. The field coils, which are form-wound, are interchangeable.

The armature is of the iron-clad type, notched to receive the windings. On the motor end these are form-wound and insulated before being placed in the notches; on the generator end the coils consist of a bare copper-wire cable with a carrying capacity of 1200 amperes without heating more than 30 degrees



Electroplating Motor-Generator.

C. above the surrounding atmosphere. The bare-wire winding is used on account of its great radiating surface and consequent ventilation, besides being easier to handle. The armature winding is in multiple, the current being collected by four sets of copper-leaf brushes, held in a rigid holder. The spring of the copper insures a good, firm contact on the face of the commutator. The commutator is built up of hard copper segments, with mica insulation, there being twelve segments to the commutator. On the motor are used carbon brushes, set in radial holders, the tension being adjusted automatically.

The bearings are phosphor bronze, self-oiling and self-aligning, and are fitted with glass sight oil gauges.

It is stated that these machines run sparkless from no load to full load without the necessity of changing the position of the brushes. Their principal constructional features are the ample size of all the parts to carry the full-rated load continuously without excessive heating; the use of the best of material and the excellence of design and workmanship. The regulation is effected by means of a rheostat in the shunt circuit connected across the main line terminals. Current is generated at a pressure of six volts.

A New Rubber Wire Factory.

The John A. Roebling's Sons Company is now manufacturing rubber insulated wires at its new factory recently completed in Trenton, N. J. The very best and latest machinery has been installed for preparing the rubber for insulating all sizes and kinds of electrical conductors from wires for houses and cars, etc., up to the heavy lead incased cables for power and light plants, working under high-tension currents. While hitherto supplying rubber insulated wires in large quantities to the trade, there has been some disadvantage in not actually turning out the product entirely from the raw material at the company's own works. With every appliance in the way of rolling mills, wire mills and other machinery it became imperative for the company to supply its own "Roebling" rubber wire to its customers, taking advantage of the reputation of the products of its mills. The new factory is located conveniently near the other parts of the electrical wire department, and has ample shipping facilities both by rail and water. The heavy machinery is installed on the ground floor of a large three-story brick building about 60 feet by 160 feet. The other floors are utilized for lighter machinery, drying rooms, etc.

The field for rubber insulation is a large one, and many varieties of conductors are manufactured,, and the Roebling Company is now equipped for handling everything of the kind that is made.

Miniature Enclosed Arc Lamp.

The miniature enclosed arc lamp of the General Electric Company promises another advance in providing for the use of arc light in smaller units so that it may compete with oil, gas and incandescent lamps in illuminating halls, offices, display windows and rooms of limited area. The illuminating power and the current are much less than those of the large lamps, so that several lamps are not more expensive to operate than one large one, while by dividing the total amount of light required the general illumination is greatly improved. The miniature arc lamp is also suitable for other places where a large arc lamp would supply more light than necessary. It is of the single globe and reflector type, the light of the arc being thrown down from the polished under surface of the reflector.

This miniature arc lamp, designed for 110-volt direct current circuits, is frequently required to operate at slightly higher or lower voltages. An adjustable resistance has, therefore, been provided in the top of the casing, which adapts the lamp to any line voltage from 100 to 120. The lamp takes, ordinarily, 2½ amperes, but a loop in the magnet coil permits an adjustment for 3 amperes. Seventy-three to 75 volts are required at the arc, and when adjusted for 2½ amperes, with a line voltage of 110, the energy at the terminals is 275 watts. Adjusted for 3 amperes the energy is 330 watts. The life is from 40 to 45 hours with standard current, and from 35 to 40 hours with 3 amperes.

Miniature Enclosed Arc Lamp and Its Mechanism.

The mechanism of the miniature arc lamp operates on the General Electric carbon-feed principle. The carbon is fed through a brass tube extending through the centre of the magnet coil. The double-cam clutch, which operates directly upon the carbon, is simple in its action and has few parts. Special attention has been given to the design of the carbon holders and the general arrangement of the frame to facilitate rapid trimming.

The principal dimensions of the lamp are:

Length over all	18½	inches.
Weight	9½	pounds.
Upper carbon	8½x⅜	inches.
Lower carbon	3½x⅜	inches.
Inclosing globe, top diameter	2	inches.
Maximum, top diameter	3	inches.
Bottom, top diameter	13-16	inches.
Height	4	inches.
Porcelain shade	11x2x2⅝	inches.

No outer globe is used. Each lamp is arranged with a switch, so that it can be readily thrown in or out of circuit.

Several hundred of these lamps have been introduced among central stations in the past sixty days, and there seems to be an increasing demand for arc lamps of small and attractive design.

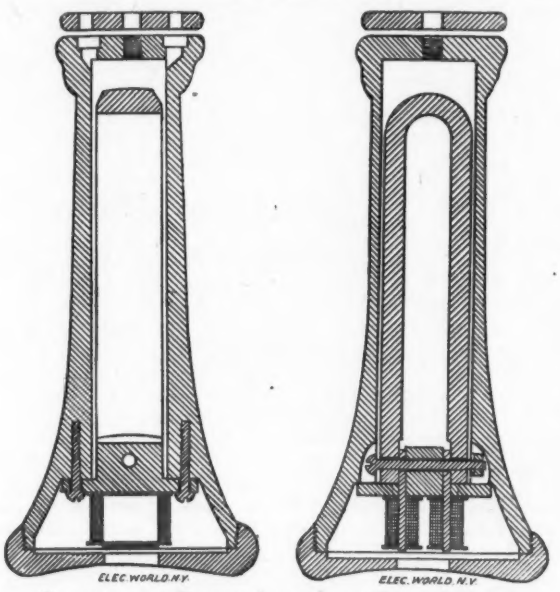
How to Install Lightning Arresters.

Mr. W. R. Garton, president of the W. R. Garton Company of Chicago, has been making some very careful experiments on various electric railways throughout the country in the matter of lightning arrester installations. As a result of this work and his observations he suggests that some information as to the proper method of installing lightning arresters would not be amiss, and at the same time calls attention to some of the improper methods practiced. "Electric railway and electric light companies," he states, "have in their employ men, classed as linemen or electricians, who are intrusted with the installation of various instruments or devices which are purchased for their plants. It is often the case that these men trust to their own judgment rather than to the judgment of the manufacturer, and install the apparatus in accordance with their own ideas. It is not to be said that these men are not oftentimes well versed and in possession of valuable information gleaned from their own practical experience, but it is always better to carry out the instructions of the manufacturer and allow him (the manufacturer) to shoulder the blame if the operation of machines or instruments is not satisfactory. The writer has found many such cases, which explain the reason for failure of lightning arresters to protect plants, transformers, etc. Lightning arrester lead wires should never be curled or twisted around span wires or tied into knots to take up the slack. If the wire is too long it should be cut to the proper length and made as straight as possible. To test lightning arrester grounds, especially on railway circuits, a bank of five lamps should be carried, and if, when the terminals of the lamp circuit are connected with the line and ground terminals of the lightning arrester, the lamps come to candle power, the ground can be considered as satisfactory. Otherwise it should be improved. As a matter of mechanical protection gas pipe has been used to cover the ground wire, and in hundreds of instances has rendered the lightning arrester useless, as the iron pipe around the wire acts as a choke to the discharge. Wherever ground wires are run to the ground through pipes they should be connected to the pipe through which they run. This applies to any wire in a lightning arrester circuit. Where installations have been made in this way I have often advised removing the insulation from the wire at the top of the pipe and driving a wooden wedge into the pipe to force the wire against the pipe, to keep it in that position. The ground wire should never be alive; therefore there is no danger from having the wire connected with the pipe. Lightning arresters which were unsatisfactory with the wire run through the pipe have proven very satisfactory after having made the changes above spoken of."

W. & C. Bipolar Telephone Receiver.

The W. & C. bipolar receiver, illustrated herewith, has just been placed upon the market by Messrs. Whitman & Couch, Boston, Mass. It is said to have been pronounced by experts as perfect as any receiver ever produced. It will enable many exchanges to improve their service and reduce expenses.

The firm claims that this instrument is in permanent adjustment and is unequalled in points of construction and efficiency. In its construction the magnets are made very heavy, with brass spools. They are secured to the pole pieces by a bolt, which binds the two parts together upon the brass bed plate. They are then fastened to the shell by two machine screws at a point so near the diaphragm that the shell may contract or expand without changing the adjustment of the instrument. The shell is made of the best rubber. Its interior form gives it great strength and at the same time affords a close jacket for the magnet. The pole pieces are of nickel-plated brass, and the soft-iron cores are milled off even and parallel.



SECTIONS AT RIGHT ANGLES TO EACH OTHER.

Water Motor for Driving Small Dynamos, Etc.

For small powers, such as are needed for the driving of small dynamos and other light power machinery, water motors may be used with advantage and satisfaction, and the demand for an efficient motor of this class has led manufacturers to give special attention to improvement in construction. The water motors made by the A. Rosenberg Company, 629 North Carey Street, Baltimore, Md., are claimed to be the best and most efficient machines of this kind that have ever been put upon the market. The motor has the additional peculiar advantage of being adjustable or tiltable in any direction while running.

The body and stand being of iron and finished in black, and the ball-and-socket joint being polished brass, the motor has a very neat and attractive appearance. Leather packing rings are inserted between the socket and the clamp ring, insuring a water-tight joint.

These motors can be set up anywhere upon the special bracket provided, and since the ball-and-socket joint admits of universal adjustment the pulley can be lined up with a dynamo, lathe, fan, sewing machine and other like machinery, and the belt tightened while the motor is in operation. It is never necessary, therefore, to cut or shorten the belt to take up slack, the latter being taken up by the adjustment of the body of the motor.

These motors are said to operate satisfactorily by the ordinary house water supply by attachment to any faucet where there is a pressure of 25 or 30 pounds or more. The 7-inch motor, which stands 15 inches high, runs at over 2000 r. p. m., with 50 to 60 pounds pressure. It is stated that these machines will last for years without perceptible wear. They are noiseless in operation, and require practically no attention save that necessary to oil the machine once a day.

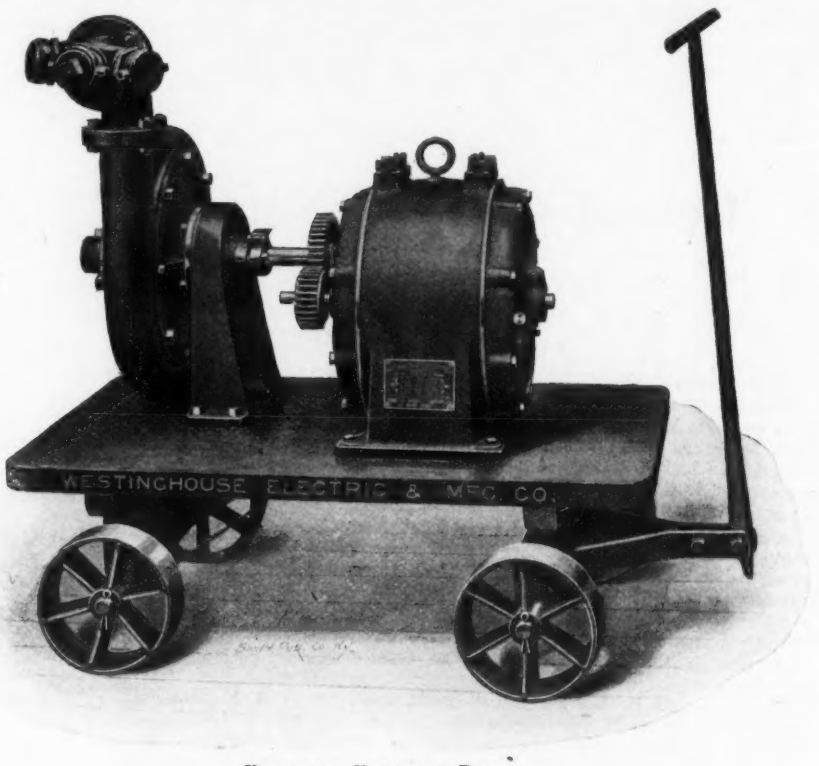
Motors are made 7 and 9 inches in diameter. It is stated that these machines do not leak at the bearings, no matter how far they are tilted or how much the bearings are worn.

Portable Electric Pumps.

The varied applications of electric power are no more strikingly illustrated than in the subject of this article. While the combination has been especially designed to be used in the California Winery, of Sacramento, Cal., it is one that may be applied to various other purposes.

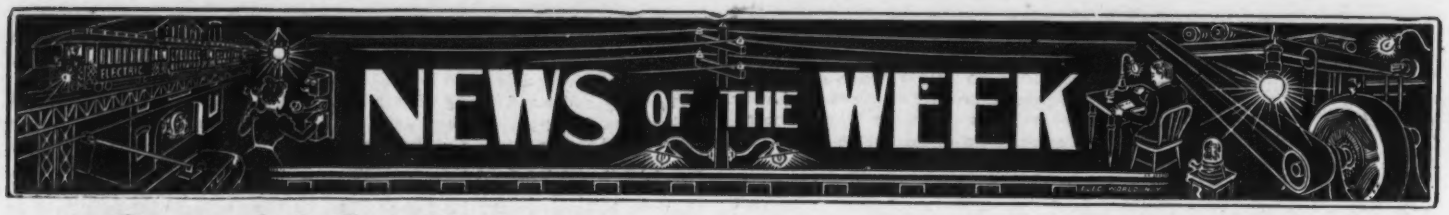
The outfit consists of a Westinghouse Electric & Manufacturing Company's type "G" alternating-current induction motor of 2-hp capacity direct-connected to a centrifugal pump. The machines are mounted upon a suitable truck, by which they are transferred from place to place in the operation of pumping wine from one vat to another. Receptacles for electrical connection are provided at convenient points throughout the winery, and the motor is connected by means of flexible cable to the circuit of the Central California Electric Company, whose power is generated at Newcastle, 30 miles distant from Sacramento.

The simplicity of both pump and motor renders them ideal in construction. The motor has neither commutator nor brushes, and there is no connection between the revolving part and the electric circuit. Beyond the occasional oiling of the bearings, no further attention is required over long periods of operation, and it may be handled by the most inexperienced persons with perfect safety.



PORTABLE ELECTRIC PUMP.

The centrifugal pump is peculiarly adapted to handle liquids of whatever nature. It is capable of pumping under the most difficult conditions, and will handle hot or cold liquids successfully, even though they contain from 30 to 40 per cent. of solids. Thus it will be seen that the applicability of the device extends beyond the luxuries of life, as in the pumping of wine, beer or other spirits, to the more arduous duty of pumping the dirty and muddy accumulations in electric subway manholes, tannery, liquids, dyes, bleaching solutions, vinegar and brine liquids used in pickling, and, in fact, is applicable to a multitude of services in the arts and manufactures in which it is destined to be a permanent economic feature.



Financial Intelligence.

THE AMERICAN ELECTRIC TELEPHONE COMPANY, Chicago, certified to an increase of capital stock from $100,000 to $130,000.

THE WEST END STREET RAILWAY COMPANY has declared a semi-annual dividend of 3½ per cent., payable September 17.

THE EDISON ELECTRIC ILLUMINATING COMPANY, of Brooklyn, has declared a quarterly dividend of 1½ per cent., payable October 1.

THE STOCKHOLDERS of the American Telephone & Telegraph Company at a special meeting on September 8 voted to increase the company's capital stock from $20,000,000 to $25,000,000.

GENERAL ELECTRIC'S NEW STOCK.—Dealings were made on the New York Stock Exchange on September 15, for the first time, in the reduced capital stock of the General Electric Company. The new stock sold at 78@78½, and the old at 46½.

THE WESTERN UNION TELEGRAPH COMPANY has declared a quarterly dividend of 1¼ per cent., payable October 15. The company's report for the quarter ending September 30 shows the following results: Revenues (estimated) $1,550,000, a decrease of $153,851 as compared with the actual revenues last year; interest $224,500, increase $82; balance $1,325,500, decrease $153,933. Dividends $1,216,990, increase $18. Surplus $108,510, decrease $153,951. Previous surplus $7,963,235, increase $315,694. Total surplus $8,071,745, increase $161,743.

THE GENERAL ELECTRIC'S CAPITAL REDUCTION.—A Boston dispatch to the "Wall Street Journal" on Friday last conveyed the information that the differences between the directors of the General Electric Company and the committee of the preferred stockholders opposing the capital reduction plan have been adjusted. The 10,000 shares of preferred stock deposited with the American Loan & Trust Company, under agreement with the preferred stockholders' committee, have been sold, subject to depositors' approval, to a syndicate of gentlemen who are interested in seeing the reorganization plan of the company carried through without delay.

THE REPORT OF THE METROPOLITAN STREET RAILWAY COMPANY, of New York, for the year ended June 30 shows the following results: Gross earnings $9,938,050, an increase of $1,049,701, as compared with the gross earnings in 1897; operating expenses $5,300,436, an increase of $490,201; net earnings $4,638,069, increase $559,500; other income $647,297, an increase of $99,768; total $5,285,366, increase $659,268; fixed charges $3,439,796, increase $252,821; balance $1,845,570, increase $406,447. Dividends $1,500,000, increase $300,000, leaving a surplus of $345,570, an increase of $106,447. Cash on hand $2,399 000, increase $2,103,987. Profit and loss, surplus $1,638,267, increase $305,779. Betterments $1,500,799 decrease $14,654.

Special Correspondence.

New York Notes.

Office of THE ELECTRICAL WORLD,
9 Murray St., NEW YORK September 19, 1898.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS has obtained temporary notoriety through the finding of one of its old-style pins upon the body of a dead woman discovered last Wednesday in the woods near Stapleton, Staten Island. The woman, who is supposed to have committed suicide, had nothing about her person that would lead to her identification, and it was thought that the discovery of the A. I. E. E. pin would be a step in clearing up the mystery surrounding the case. This clue, however, amounted to nothing, as there are plenty of other pins just like it worn by members of the institute. The old pin was supposed to be kite-shaped, but it suggested a coffin as much as it suggested a kite, and that one of these reminders of the end of material existence should be found on a dead body is a rather odd circumstance.

VALUABLE WHISKERS AND HAIR—Mr. Max Meyer has brought an action against the United States Electrical Supply Company of this city to recover $10,000 damages for the loss of his whiskers and also the hair on the right side of his head. He had charge of the company's X-ray exhibit at the Electrical Exhibition at Madison Square Garden last May and believes that the cause of his affliction was due to the handling of the fluoroscope. Mr. Meyer states that after about ten days he felt a peculiar itching on the right side of his body. His face afterward began to shrivel, and his beard, hair and mustache on the right side began to drop off. A physician told him that the right side of his body had been "cooked," and Mr. Meyer asserts that the cooking was done by the fluoroscope which he handled at the exhibition. He asserts that the company should have warned him of the danger attending the exhibition of X-rays.

OVERTIME ON THE BROOKLYN TROLLEY ROADS.—It is alleged that the employees of the Brooklyn trolley companies are compelled to work overtime two or more hours each day. District Assembly No. 75, Knights of Labor, which is composed of the surface railway employees, has taken the matter up, and a delegation of that body called upon District-Attorney Mareau last Tuesday to see what action could be taken to bring about a closer adherence to the law regulating the working hours of railroad employees. The penalty for a violation of the law is a fine of not less than $300 nor more than $1000. It was decided that the District-Attorney should bring the matter to the railroad companies' attention, as it was possible that they had misunderstood the statute. There seemed to be a disposition on the part of the men to bring about an amicable settlement of their grievances.

THE NASSAU AND BROOKLYN RAPID TRANSIT COMPANY MAY CONSOLIDATE.—It is stated that negotiations are in progress in Brooklyn looking to either a consolidation of the Nassau Electric Railroad Company and the Brooklyn Rapid Transit Company, or a long lease of the former by the latter. It was reported that the Rapid Transit Company on Saturday last purchased more than half of the stock of the Nassau Company. This, however, does not include the holdings of Albert and Tom L. Johnson and P. H. Flynn. The attitude of these three interests toward the consolidation plan seems to be uncertain. It is stated that the Johnsons will not sell unless their holdings are purchased in their entirety; another report is that they will sell at their price. On the other hand Mr. Flynn, it is stated, is unalterably opposed to allowing the Rapid Transit Company to get a lease of the Nassau lines or to consolidation under any circumstances. The Rapid Transit people believe that if they can obtain control of two-thirds of the stock they could secure the desired lease or consolidation, but how they are to get the necessary additional number of shares to accomplish this result is yet, according to reports, a question for the future to determine. The plan to combine the Brooklyn railway interests has been talked of for a long time. Ex.-Gov. Roswell P. Flower and his associates, who control the Rapid Transit Company, have been in favor of the combination, and believe that it will not only result in increased earnings, but in better transportation facilities for the general public. It is said that the Brooklyn companies were all sounded some time ago and that negotiations for the absorption of the Coney Island and Brooklyn road are now under way. It has been said that the Rapid Transit folks have even the absorption of the elevated railroads in mind. Negotiations were started some time ago, but abruptly broken off. However, they are reported to be in such condition that they can be taken up again at any time. It has been estimated that the combination of all of the transportation facilities in Brooklyn would result in a great saving of expenses. Where the lines compete a greatly decreased number of cars might do the business, and the jam on the bridge could be lessened without seriously affecting the convenience of the public. It is said that the saving in power would alone amount to half a million or more dollars a year if the Nassau road could be absorbed.

Philadelphia Note.

Branch Office of THE ELECTRICAL WORLD,
929 Chestnut Street,
PHILADELPHIA, Pa., September 17, 1898.

PAPERS ON RAIL BONDING AND THE STORAGE BATTERY.—A meeting of the electrical section of the Franklin Institute will be held at 8 o'clock on the evening of September 27. Two interesting papers will be presented, one by Mr. W. E. Harrington on the subject, "Rail Bonding, with Special Reference to Cast-Weld Joints," and the other entitled "The Present Status of the Storage Battery," by Mr. Herbert Lloyd.

Buffalo and Niagara Falls Notes.

BUFFALO, N. Y., September 17, 1898.

THE CATARACT POWER & CONDUIT COMPANY, which delivers all power from the Niagara tunnel to outlying towns, is now assured of the needed franchises in both Tonawandas. These towns always insist on an agreement to make rates lower than those for towns on longer lines.

LOCKPORT is to have a power line direct from the Niagara tunnel. The changing of the line of the Erie Railroad from Tonawanda to that city into an electric line makes it easy to carry the cables to Lockport, and this will be done soon. The stepping down of the 11,000-volt current will be effected in the transformer station at North Tonawanda, now building. The consumers of current generated in Lockport are eager for the cheaper current.

IT WAS ANNOUNCED some days ago that the Buffalo North Main Street & Tonawanda trolley line had been abandoned and would be taken up at once. This line was built, as were others, as a part of a land scheme, but when the boom went to pieces the road fell into the hand of the General Electric Company, no doubt to meet its demands for apparatus and supplies. Mr. G. Morgan, of Tonawanda, is managing the road for the company, and it is now stated by the company that the story of abandonment is premature. The road therefore may be given a further lease of life.

Chicago Note.

Branch Office of THE ELECTRICAL WORLD,
986 Monadnock Building,
CHICAGO, Ill., September 16, 1898.

MESSRS. J. A. WILLIAMS and B. S. Chamberlin, president and general manager and secretary and treasurer, respectively, of the Williams Electric Company, Cleveland, Ohio, paid Chicago a visit during the present week.

ST. LOUIS NOTES.

ST. LOUIS, Mo., September 15, 1898.

THE CITIZENS' ELECTRIC LIGHT & POWER COMPANY will finish the work of laying its conduits next Saturday night, and will then be ready to erect a power house.

ON SUNDAY last the Kinloch Telephone Company erected some poles in an aristocratic portion of the city, over which work the residents threaten to go to law. Being Sunday the residents could not get an injunction.

THE CITIZENS' ELECTRIC COMPANY will not be under the necessity of erecting poles over the city, as it has leased cross-arm privileges from the Kinloch Telephone Company. The Kinloch Company has some 9500 poles.

THE STRIKING LINEMEN and men who are still at work for the electric companies came into conflict with one another several times last week. On two or three occasions the fights were so serious that the police were called out.

THE MISSOURI-EDISON ELECTRIC LIGHT & POWER COMPANY put eighteen men to work this week in different parts of the city. These men were brought from Kansas City to take the place of the striking linemen. There are more on the way here from Kansas City and Toledo.

THE NEW TELEPHONE SERVICE.—The Kinloch Telephone Company's service will open October 1. Four-fifths of the number of connections on the switchboard have been tested, and the rest will be tested within the coming week, leaving nothing to be done except to break in the "hello" girls, which is to be done gradually.

RECEIVER F. B. BROWNELL, of the People's Railway Company, has filed a report for the month of August, showing that the road has been operated at a profit during the month. The cash on hand August 31 was $10,491.57. The bill due amounted to $679.65, and the wages amounted to $3532.15, leaving cash resources of $6279.77.

PACIFIC COAST NOTES.

SAN FRANCISCO, Cal., September 11, 1898.

MR. DANIEL MASON, construction engineer for the Sprague Electric Company, who has spent the greater part of the past two years on this coast in connection with elevator work, recently left for Chicago and the East.

THE LATEST FAD of wealthy residents along the shores of Lake Merritt in Oakland, Cal., is to erect searchlight towers, from which they produce spectacular effects by sweeping the lake and the neighboring country side with powerful rays of white light.

THE SHEEP RANCH MINE COMPANY, of California, is said to have closed a contract with the Westinghouse Electric & Manufacturing Company for the installation of a two-phase electric transmission plant, having a capacity of 5000 horse power. Water power will be utilized.

THE UNITED STATES SIGNAL SERVICE is constructing a telephone system up Mount Tamalpais, 13 miles from San Francisco. A station was established a short time ago at the summit, and the observer will soon be able to announce by telephone sudden changes of weather, etc.

OWING TO the delay in approval of the franchise for the Hawaiian cable line, it is said the Pacific Cable Company has been considering a plan to lay a cable from Alaska and not touch the Hawaiian territory. It is estimated that a cable could be laid to reach Australia and the Philippines and terminate in China for $5,000,000, while an additional expense of $7,000,000 would be incurred if the cable should touch at Honolulu.

THE FORTY-FIVE CONSOLIDATED MINING COMPANY recently let contracts for the erection of a concentrator, having a daily capacity of 75 tons of ore, in the Sultan mining district, Washington. An electric transmission system will be installed, crossing the Williamson Creek Valley. A Tuthill water wheel will be installed to drive the generator, at Copper Lake Falls. Ore is now being taken out in small quantities.

MR. CHARLES F. SCOTT, chief electrician of the Westinghouse Company, recently made a tour of the Pacific Coast, during which he inspected the headworks at Snoqualmie Falls, Wash., where his company will install four 1500-kw generators for the Snoqualmie Falls Power Company. The generators will be placed at the bottom of the shaft, 300 feet below the surface of the ground. The water will be piped to the direct-connected wheels.

CANADIAN NOTES.

OTTAWA, Ont., September 16, 1898.

MR. J. W. POUPORE, M. P. for Pontiac, is negotiating with an American syndicate, capitalized at $5,000,000, to erect smelters at Ottawa and on the Georgian Bay in connection with the Ottawa ship canal. In relation to this, a gentleman is in this city to patent an electrical smelter.

THE BIG FAIR at Toronto, Ont., proved a bonanza to the electric street railway of the city. The total number of passengers carried during the fair was 1,879,298, exclusive of transfer passengers. The increased earnings exceeded those of last year, during the same period, by $15,167.

THE CITY COUNCIL of Toronto, Ont., has accepted the tender of the Sprague Electric Company of New York for the supply of three electric elevators, with the plant for five, for the new municipal buildings of Toronto. The architect states that the electric plant will operate 300 or 400 lights in addition to the power required for running the elevators.

A JUDGMENT has been delivered by Judge Loranger, at Montreal, which declares that the rolling stock of the Montreal Street Railway, its rails, wires and poles are subject to assessment for municipal purposes. Hitherto they have not been taxed. The recent decision of the Ontario courts, declaring the right of the city of Toronto to assess such rails, wires and poles, has had the effect of stirring up an agitation in Montreal, resulting in the judgment referred to.

THE ROYAL ELECTRIC COMPANY, of Montreal, will hold a special meeting on October 18 next for the purpose of authorizing an issue of preferred stock and the acquisition of shares in the Chambly Manufacturing Company for an additional amount of $100,000. The Royal Company has heretofore been paying 4½ per cent. on its mortgage bonds, and a higher rate of interest for its customers' paper. The company's credit being excellent, any money required can be obtained in England at a much lower rate of interest, and the board deems it in the interest of the shareholders to avail themselves of that credit, instead of issuing common stock at once for all the money needed, which stock would carry 8 per cent. dividend.

ENGLISH NOTES.

(From Our Special Correspondent.)

LONDON, September 7, 1898.

MR. BRUSH'S NEW GAS.—Considerable scepticism is shown on this side of the Atlantic as to Mr. Brush's discovery of new gases. Had he contented himself with the discovery of a single new constituent of the atmosphere he would not have been so severely criticised. But serious doubts are entertained as to his "periodic group of new elements," which is announced by cable.

THE DEATH OF DR. JOHN HOPKINSON.—The news of the sad death of Dr. John Hopkinson will, of course, have reached New York by cable. His loss is very keenly felt in the whole electrical profession. He was not only a distinguished scientist, but was foremost in the ranks of dynamo designers and consulting engineers. He was loved and respected by all who came in contact with him, and deep sympathy is felt with his widow and children, as well as with his parents, who are still living, and his brothers. The funeral took place at Territet, Switzerland, on Friday last. It was first intended to have the funeral in Dr. Hopkinson's native town, and the Institution of Electrical Engineers proposed to send representatives. In the circumstances they had to be content with sending a wreath and passing a special resolution of sympathy.

OBITUARY.—News has just come to hand of the death of Col. Henry Lake Wells, C. I. E., R. E., director of the Persian section of the Government telegraphs, of enteric fever. He died at Karachi on August 21 last, after an illness of only six days. Colonel Wells' career was a most distinguished one. After efficient service in the Afghan campaign of 1878-79, he was appointed assistant director of the Persian section of the Government telegraphs, and in 1885 was promoted to the post of director. He was frequently mentioned and praised in Government dispatches, and was considered one of the best officers in the service. He showed admirable spirit and set a thorough good example during the cholera epidemic of 1893. Among other recognitions for his services in Persia he received the sword of honor from the late Shah and a valuable diamond ring from the present Shah. A paper on "Telegraphs and Trade Routes in Persia" was contributed by him to the Society of Arts in 1894. The deceased leaves a widow and five children.

THE 1898 MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—The annual B. A. meeting opens to-day at Bristol with the presidential address by Sir William Crookes, F. R. S. A number of most interesting papers are down for reading in Section A (mathematical and physical science) and in Section G (mechanical science), these two sections being under the presidency of Professors W. E. Ayrton, F. R. S., and Sir John Wolfe-Barry, F. R. S., respectively. In the latter section I may mention the following papers: "Some of the Mechanical and Economic Features of the Coal Question," by T. Forster Brown; "Description of an Instrument for Measuring Small Torsional Strains," by E. G. Coker; "A New Instrument for Drawing Envelopes, and Its Application to the Teeth of Wheels and for Other Purposes," by H. S. Hele-Shaw; "Electric Power in Workshops," by A. Siemens; "The Application of the Electric Motor to Small Industrial Purposes and Its Effects on Trade and on the Community Generally," by A. H. Gibbings; "Electric Power and Its Application on the Three-Phase System to the Bristol Carriage and Wagon Works," by W. Geipel; "Notes on the Electric Lighting System at Bristol, with Special Reference to Auxiliary Plant," by H. Faraday Proctor; "Corrosion of Gas and Water Mains by Earth Currents from Electric Tram Lines," by Prof. J. A. Fleming; "Combined Electric Lighting and Power Plant for Docks and Harbors," by T. G. W. Aldridge, and "Electric Canal Haulage," by A. H. Allen. Among the papers down for Section A are two by Professor Ayrton's students. The one of these which will awaken most interest is by Messrs. Cahen and Donaldson, and contains a comparison of the two methods of charging secondary batteries, viz., at constant potential and constant current. The conclusions in this paper will no doubt be of considerable practical as well as theoretical importance, especially in the application of the secondary cell to traction work. Another paper is by Mr. Maurice Solomon on "A Determination of the Temperature Coefficients of Two 10-Ohm Standards." In connection with this section there is to be an international conference on "Terrestrial Magnetism and Atmospheric Electricity," under the presidency of Prof. A. W. Rucker, M. S., D. Sc., which I expect will bring forth some useful information on this subject. On Monday evening a discourse is to be delivered by Mr. Hugh Jackson on "Phosphorescence." A number of excursions to places of interest in the neighborhood of Bristol will be made on the afternoon of Saturday next and on Thursday, the 15th inst.

General News.

NEW INCORPORATIONS.

THE HOME TELEPHONE COMPANY, Woodruff, S. C., has been formed by E. F. Pearson, president; L. H. Irby, secretary; S. J. Workman, treasurer.

THE MISSOURI & ILLINOIS TELEPHONE COMPANY, Meyer, Ill., has been formed with a capital stock of $2500. The incorporators are O. C. Clay, W. B. Henton and H. C. Chinn.

THE LEWISTON & GREENE TELEPHONE COMPANY has been incorporated at Portland, Me., with a capital stock of $10,000. The officers are: President, William Williams, Monmouth; treasurer, Walter H. Bean, Lewiston.

THE MIDLAND TELEPHONE COMPANY, Kimbrae, Minn., has been incorporated with a capital stock of $50,000. Among those interested in the new company are C. J. Smallwood, Daniel Shell and H. N. Douglass, of Worthington; Charles Mylius, L. M. Kaplan and A. M. Becker, of Adrian.

THE AMERICAN INDIES COMPANY has filed articles of incorporation with the Secretary of State at Trenton, N. J., with a capital stock of $18,000,000. The purpose of the company is to build and operate electric plants, telegraph, telephone, steamship and railway lines, to conduct real estate and mining operations and to carry on business in a number of other branches in Cuba and Porto Rico. The incorporators are Thomas Dolan, P. A. B. Widener and W. L. Elkins, Philadelphia; Thomas F. Ryan, Frederick P. Olcott, A. N. Brady, R. A. C. Smith, Henry D. Macdona, N. Ceballos, Guillermo de Zaldo, H. P. Booth and H. G. Runkle.

THE TELEGRAPH AND TELEPHONE.

KANSAS CITY, MO.—The purchase of a fire and police alarm system in this city is contemplated.

PAOLA, KAN.—The franchise of the Osawatomie Telephone Company has been assigned to the Paola Telephone Company, and the exchanges of the two cities are now under one management.

SAN DIEGO, CAL.—The Sunset Telephone Company is preparing to put up a fine system of poles and wires at Coronado. A submarine cable has also been purchased to be laid under the bay.

RENOVO, PA.—The Central Pennsylvania Telephone & Supply Company has begun the work of constructing a telephone line between Lock Haven and Renovo. It is expected to have the line completed in from six to eight weeks.

GREELEY, IA.—The Bishop Telephone Company, of Central City, Ia., has completed its line to Greeley. This will give the public direct connection with 650 'phones in Cedar Rapids, 500 in Waterloo, 150 in Manchester and 150 in Laport City.

CANISTEO, N. Y.—The Jasper & Canisteo Telephone Company has been organized, with the following officers: President, Chauncey E. Brown; vice-president, John H. Strait; secretary, Willis A. Schenck; treasurer, Leslie D. Whiting. Poles are being set and the line will be opened about October 1.

HOUSTON, TEX.—The Southwestern Telephone & Telegraph Company has received a carload of material at this place for the construction of another territorial line between Temple and Belton. There are now two lines between the two places, but the great amount of business between them requires another which will be erected.

PORTAGE, WIS.—The Central Wisconsin Long Distance Telephone Company has been organized in this city. It will build a line to Westfield, Oxford, Montello, Packwaukee and Endeavor, and will extend it to points in Adams County. The officers are: C. A. Colonius, president; J. H. Bryan, secretary and treasurer; F. E. Bell, general manager.

BOSTON, MASS.—The statement of the output of instruments by the American Bell Telephone Company for the month ended August 20 shows: Gross output 24,863, increase 9,096; returned 12,022, increase 1,868; net output 12,841, increase 7,228. From December 21 to August 20: Gross output 212,747, increase 69,202; returned 95,328, increase 33,327; net output 117,419, increase 35,875. Total output August 20 1,036,541, increase 182,370.

ELECTRIC LIGHT AND POWER.

SHELBINA, MO.—The citizens of this place have voted to issue $5000 in bonds for the establishment of an electric light plant.

WOOSTER, OHIO.—A special election is called for October 3 to vote on the question of issuing $25,000 in bonds for the purpose of building a municipal lighting plant.

RICHLAND CENTRE, WIS.—The City Council is contemplating the erection of an electric plant for the purpose of lighting the streets of the city, and a committee has been appointed to draw up plans to that end.

SHERMAN, TEX.—The Commissioners of Public Works met and decided, after discussing the enlargement of the city street light system, to purchase an additional dynamo capable of running eighty arc lights of 2000 candle power each. The work of overhauling and extending the present system will begin as soon as the Board of Aldermen ratifies the recommendation of the commission.

ERIE, PA.—An application will be made for a charter of incorporation for the Erie County Electric Company. The incorporators are Messrs. William C. Readio, William E. Brown, William S. Carroll, William G. Reed and Fred Einfeldt. The object of the company is the production of electricity for heat, light and power and supplying the same to the public.

UNADILLA, N. Y.—The Standard Light, Heat & Power Company has filed papers of incorporation. Capital, $60,000. It intends to furnish electricity for the villages of Unadilla, Gilbertsville and Otego, Otsego County; Sidney and Franklin, Delaware County, and Bainbridge and Afton, Chenango County. The directors are H. G. Danfield, S. E. North, J. F. Sands and D. R. Buckley, all of Unadilla.

THE ELECTRIC RAILWAY.

REDKEY, IND.—The Redkey Traction Company has secured a franchise, and will build an electric line from Dunkirk through Redkey to Pennville.

PITTSBURG, PA.—The rumored purchase of the Homestead & Highlands Street Railroad by the Consolidated Traction road is denied by President C. L. Magee, of the Consolidated Traction Company.

SEDALIA, MO.—The Citizens' National Bank, representing the interests of the late Judge D. C. Metsker, sold the stock of the Sedalia Electric Railway, Light & Power Company and the Sedalia & Brown Springs Electric Railway Company to Stewart & Co., of New York, the consideration being $400,000.

DOYLESTOWN, PA.—The Newtown Street Railway Company is extending its interests. It has just consummated an important deal by the purchase of the road and rolling stock of the Newtown, Langhorne & Bristol Trolley Company.

WATERVILLE, ME.—S. Furgeson & Son, of this city, have received contracts for constructing a two-mile electric railroad between the Kennebec River at Fairfield and Benton Falls on the Sebesticook. The rails will be laid so the Maine Central Railroad cars can run over the same, and the road will be used principally for transportation of freight.

WAUTOMA, WIS.—A scheme is now on foot for the building of an electric railroad from Berlin to this village, through the towns of Aurora, Pine River and Mount Morris. The road would be called upon to handle a large amount of freight, as this section has no railroad within a radius of 20 miles and is one of the best farming districts in Waushara County.

McKEESPORT, PA.—The new Homestead & Highland road to McKeesport is nearing completion. It runs along the south bank of the Monongahela to Duquesne, where it crosses the river and goes into McKeesport over a private right of way, bought at a cost of about $80,000. The company is now erecting a bridge over the Baltimore & Ohio and Pittsburg, McKeesport & Youghiogheny Railroad tracks at Riverton Street, to get into McKeesport without a grade crossing.

BUFFALO, N. Y.—A certificate of consolidation of the Buffalo, Tonawanda & Niagara Railroad and Tonawanda Electric Railroad has been filed. The consolidated road will be known as the Buffalo, Tonawanda & Niagara Falls Electric Railroad, with these directors: Henry B. Smith and H. M. Gillett, of Bay City, Mich.; T. E. Ellsworth, of Lockport; George Sandrock, James A. Roberts and C. M. Howard, of Buffalo; James Low, of Niagara Falls, and J. A. Read and B. S. Rand, of North Tonawanda.

ELIZABETH, N. J.—The Elizabeth Street Railroad Company, of which John Kean is president, has notified the Union County Board of Freeholders that it has filed its bond for $250,000, the price of the franchise agreed upon, to operate a trolley line between Elizabeth and Plainfield. The single fare will be 15 cents. The company also stated that it would at once change the motive power of the East Jersey Street line from horse to electricity from Staten Island ferry to the Central Railroad station on Broad Street. It is believed that the trolley line will be in operation by December 1.

NEW YORK, N. Y.—It is announced that the Union Railway Company has purchased the property of the Yonkers Electric Company, and now proposes to make important extensions to its lines from its present terminus at Hastings along the Albany Post road through Dobbs Ferry and Irvington to Tarrytown. The Pelham line, which is being extended to New Rochelle, will be continued to Larchmont and Mamaroneck, and there connect with the trolley road extending across country from the Sound, through White Plains to Tarrytown-on-the-Hudson, thereby connecting eleven towns by an electric railway loop more than 40 miles in circumference.

CHICAGO, ILL.—In addition to the work recently completed by the South Side Rapid Transit Company, whereby a change was made from steam to electric motive power, at a cost of $850,000, the company has now under way two electric storage plants at a cost of $125,000. One is located on Sixty-first Street, the other at Twelfth Street, each occupying a new building 50 by 130 feet in size. The plant is intended to store electrical power during hours when traffic is light, so that it can be utilized during the busy time. There are two batteries, each capable of receiving and delivering 700 horse-power an hour. The system was designed by Messrs. Sargent & Lundy, of Chicago, and is being put in by the Electric Storage Battery Company, of Philadelphia.

PETERSBURG, VA.—In the proceedings for foreclosure pending against the Petersburg Electric Railway Company in the Hustings Court, Commissioner Robert Gilliam has filed his report showing the indebtedness of the road, and a decree directing the sale of the road will be asked of the Hustings Court. Exclusive of the bonded debt, or mortgage, the indebtedness is small and the amount of debt unsecured is insignificant. The road has been in the hands of W. P. McRae as receiver since April last, and the report shows that it has during that time more than paid expenses of operation. The entire franchises and property of the road will, shortly after the decree which is expected, be sold at public auction by commissioners to be appointed by the court for that purpose.

PENN YAN, N. Y.—It is said that promoters are busy agitating the project of a trolley line to connect Syracuse and Corning, the plan involving the consolidation of six traction companies, the Corning City line, the Penn Yan Suburban road, the Geneva, Waterloo, Seneca Falls & Cayuga Lake Traction line, the Auburn & Moravia road, the Auburn City line and the lines in Syracuse. In order to make an unbroken line of 133 miles of road it will only be necessary to build roads connecting Corning and Penn Yan, Cayuga Lake Park and Moravia, or Auburn, and Auburn and Skaneateles, if other lines already projected are carried out according to present plans. There are already power houses at Corning, Penn Yan, Waterloo, Cayuga Lake Park, Moravia, or Cayuga, Auburn and Syracuse, which, it is said, would be sufficient to supply power for the proposed line.

PATERSON, N. J.—There is much rejoicing among residents of Bergen County over the fact that the long looked for trolley road from Leonia to Hackensack is now absolutely assured, work having been begun. The trolley people have been endeavoring to secure a right of way to the county seat for the last two years, but obstacles were encountered, and it was not until a few months ago that they secured the right of way to the outskirts of the town of Hackensack. When application for a franchise was made to the local authorities of the latter town they refused to grant it. A few weeks ago the Erie Railroad came to the assistance of the trolley people and granted them a right of way through a tract of land owned by them in Hackensack, thus enabling the trolley to reach the heart of the town through private property. The road is a branch of the Bergen County Traction Company's line, which at present runs from the Fort Lee ferry to Englewood. It will connect the Palisade region and Hudson River towns with the interior of the county, which sections now

are separated from one another. The trolley will open up a part of the county admirably adapted for homes, and consequently the value of real estate will be greatly enhanced. The road is less than 4 miles in length. It will cross the Hackensack meadows over a substantial steel trestle, while the Hackensack River will be crossed by an ornamental steel plate girder bridge of 125-foot span. The officers of the road are: Jacob E. Ridgway, president; W. N. Clark, vice-president; W. N. Barrows, secretary and treasurer; E. W. Lawson, manager. The engineer in charge of the work is Ralph Crump, of Boston.

EDUCATIONAL NOTES.

ELECTRICAL ENGINEERING AT THE DREXEL INSTITUTE.—The course of electrical engineering at this well-known Philadelphia institution offers unusual facilities for instruction, and is designed to make the instruction both scientific and practical. The laboratories have been equipped with the newest forms of apparatus and every appliance necessary for efficient training. Evening classes in applied electricity are held, using the same laboratory facilities, and the instruction is by the same teachers as in the day work. The evening classes run from October 1 to April 1. Prof. Arthur J. Rowland is in charge of the electrical engineering course. He and William B. Creagmile are the instructors of the evening classes in applied electricity.

THE ROCHESTER ATHENEUM AND MECHANICS' INSTITUTE, Rochester, N. Y., is entering upon its fourteenth year with an organization embracing various departments, including industrial and manual training, mechanical and fine art and domestic science. Each department is designed to give scientific instruction necessary for equipping students for some mechanical, artistic, scientific or domestic pursuit. There are day and evening classes in mechanical drawing, mathematics, electricity, telegraphy, etc. The institute has just issued a circular of information on the subject of its work, from which it appears to offer an excellent opportunity to young men and young women to improve their knowledge. Mr. William F. Peck is the corresponding secretary.

THE HENRY ELECTRICAL SOCIETY.—The announcement of this society for the season of 1898-99 sets forth the objects of the society and its methods of teaching. The society, which is the electrical section of the American Institute, holds meetings every Tuesday evening in Enginering Hall, Columbia College, for class instruction. The first year class will meet every Tuesday evening from 7:45 to 8:45 for the study of elementary algebra, and on alternate Tuesdays, from 8:45 to 9:45 for the study of electrical units, with a preparatory course in elementary mechanics. The second year class will meet on alternate Tuesday evenings from 8:45 to 9:45 for the study of the principles, calculations and construction of dynamo electric machinery. On each alternate Friday evening a lecture will be delivered on a subject to be announced prior to the meeting. Visits to central stations and electrical plants form an important feature of the work of instruction. The class year begins on the first Tuesday in October and ends on the last Tuesday in May. The headquarters of the society are at 111 to 115 West Thirty-eighth Street.

TEACHING BY CORRESPONDENCE.—The International Correspondence Schools, Scranton, Pa., after an experience of seven years in this method of imparting knowledge, enjoy a reputation that can only arise from intelligent and painstaking effort, and the resulting satisfaction to their students. Although this form of teaching is simple, it requires the experience of years before instruction can be prepared so that the mastery of a subject can be assured the student. Successful results depend largely upon the perfection of arrangement of the literature, since the student is encouraged in his work by a thorough understanding of the instruction without the aid of a teacher. Practical questions are arranged by the schools so that the application of theory to practice is fully and easily comprehended. In correcting the work of the students, which is submitted through the mails, it is stated that the schools employ a force of 500 professors, instructors, draftsmen, assistants, etc., who are housed in a building in Scranton recently constructed for the school work at a cost of $250,000. The schools have established a New York agency at 14 East Seventeenth Street, through which, it is stated, several thousand students have been enrolled since February of this year. Each student receives bound volumes of the course which he is studying. These are extremely valuable for reference.

PERSONAL NOTES.

MR. MORGAN BROOKS, of Minneapolis, Minn., has been called to the professorship of electrical engineering at the University of Nebraska, at Lincoln, which position was made vacant by the resignation of Prof. R. B. Owens. Mr. Brooks is a graduate of Brown University and Stevens Institute, and has delivered lectures upon electrical topics to the students at the University of Nebraska. He is president of the Electrical Engineering Company, of Minneapolis, and by reason of his technical and business ability he is well qualified to fill his new position. It is stated that his business interests in Minneapolis will remain unchanged.

MAJOR J. O. KERBEY, who is now at Wilmore, Pa., and who has given considerable study to and investigated the subject of rubber production, is of the opinion that rubber will grow in Cuba. If it can be grown there a great deal of time and money can be saved to the manufacturers. Major Kerbey will shortly leave for Peru to complete the negotiations for the rubber forests on the upper Amazon for an English syndicate. He will stop at Cuba and Porto Rico en route to study the conditions for rubber culture, and if they prove to be favorable he will endeavor to interest American capital in the enterprise. He will, while in Peru, collect seeds and plants of the genuine hevea or Para rubber, and bring them to Cuba for experimental cultivation. While in South America he will also give his further attention to the development of gutta-percha, which he found in the upper Amazon.

Trade and Industrial Notes.

THE RECENT fluctuations in the prices on sockets, receptacles, cut outs, insulators, etc., have made it somewhat difficult for the ordinary buyer to keep track of the market prices on these goods. The Electric Appliance Company, Chicago, Ill., has just issued a special price list of all of this material, giving trade prices that are up to date. It is in the form of a small circular, which should be of considerable value to the purchaser of staple electrical supplies.

ELECTRIC ROCK DRILLS.—The Marvin Electric Drill Company, Canastota, N. Y., has issued catalogue B, describing and illustrating its electric percussion drills. This system of drilling was fully described in THE ELECTRICAL WORLD of February 26, 1898.

SPEAKING TUBES are so closely related to electrical signaling devices, such as bells, annunciators, etc., that it may not be wholly irrelevant to refer to the special feature of the speaking tube manufactured by the Western Electric Company, Chicago. This company has for a number of years made its tubing with lap-weld seam, which is practically air tight, and is an added element of strength. The best grade of tinned sheet iron is used in their manufacture, and the tubes are uniform in material and shape.

THE LAKON COMPANY, manufacturer of the LaKon transformer, has issued a 32-page pamphlet devoted to explaining some of the peculiarities of alternating currents. A unique feature of the pamphlet is the entire absence of any algebraic formulæ. To avoid the use of mathematical expressions was difficult, but it has been successfully accomplished in this little work, and much valuable information is conveyed to the reader. A copy will be mailed to anyone interested in transformers by addressing the LaKon Company, Elkhart, Ind.

THE AMERICAN WHEELOCK ENGINE COMPANY'S EXHIBIT AT BOSTON.—In the description of the exhibits at the Boston convention of the American Street Railway Association, published in last week's issue of THE ELECTRICAL WORLD, it was stated that the exhibit of the American Wheelock Engine Company was in charge of Mr. J. L. Kimball, the company's New England agent. This was an error. The company has no New England agent; Mr. Charles C. Hardy, manager of the company's works at Worcester, was in charge of the exhibit.

THE DRAKE TELEPHONE COMPANY, McConnelsville, Ohio, has just issued a pamphlet describing the Drake selector system. This is said to be the latest, most improved and only form of selector device now in practical operation. It is combined with a regular telephone outfit, and dispenses with a switchboard and central office, day and night operators and numerous other employees usually found necessary to keep a telephone plant in operating condition. It requires but two line wires, and it is entirely under the control of each subscriber.

MESSRS. K. McLENNAN & CO., 100 Washington Street, Chicago, state that their commutator compound can be used on collector rings with as good results as on commutators. Wherever there is trouble from sparking of brushes Gale's commutator compound, it is stated, will entirely overcome the difficulty. The increased demand for the compound has necessitated an enlargement of the firm's laboratory, and it now has facilities to fill all orders without delay. It is claimed by the company that nearly every user of a generator or motor uses its compound. Those who have not tried it can obtain a sample free upon request.

THE WESTERN ELECTRIC COMPANY, Chicago, devotes its Bulletin "5 In." to Western Electric station instruments. These instruments include arc ammeters (made in one size), current direction indicators (one size), voltmeters, eight sizes), and ammeters (seventeen sizes, ranging from five amperes capacity to 2000 amperes). The arc ammeters, voltmeters and ammeters are practically dead beat, and do not contain springs nor permanent magnets in their construction, the voltmeter and arc ammeter being said to be accurate within 1 per cent. The current direction indicator is adapted for use upon arc circuits or both high and low tension systems of any manufacture, and gives a visible indication of the direction of the current flowing through the circuit.

THE ELECTRICAL TRADE will be interested to learn of the recent arrangement made by the Western Electric Company to exclusively represent the Stanley Electric Manufacturing Company in Michigan, Ohio, Kentucky, Tennessee, Alabama, Mississippi, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, Arkansas, Louisiana, Texas, Indian Territory, Oklahoma, Kansas, Nebraska, South Dakota, North Dakota, Montana, Wyoming, Colorado and New Mexico. A complete stock of transformers and other appliances will be carried in Chicago to insure prompt shipment. Correspondence is solicited from intending purchasers of alternating apparatus for any purpose, single phase, polyphase, power transmission, transformers, switchboards, instruments, etc.

THE LEATHER PRESERVER MANUFACTURING CORPORATION, 27 West Monroe Street, Chicago, is doing a very satisfactory business in the renovation and repairing of belts. By its method the machine oil is extracted from oil-soaked belts, and the belts are otherwise put in first-class condition. The company also recements seams and laps, and lengthens and shortens belts when desired. It offers the most liberal terms to secure business, and this policy no doubt is a wise one, judging from the class of customers it has. It has recently cleaned three large belts for the Wells French Company, Chicago, and three large ones for the Joliet Penitentiary. It has also cleaned the main driving belt of the Consolidated Steel & Wire Company, at Joliet, Ill., replacing it on the pulleys, ready to run, in forty-eight hours.

A DIGEST OF TELEPHONES AND ACOUSTICS covering the United States patents in these lines from 1889 to 1898, inclusive, is being prepared by Mr. James T. Allen, examiner in the United States Patent Office, on authority of the Commissioner of Patents. The edition is to be limited to 200 copies, and should be of considerable value to those interested in the telephone patent field. It is carefully classified and indexed, and will be illustrated by reproductions of drawings of the important references. This digest is to be followed by others, embracing various classes of the electrical devices such as lighting, railways, generation, motive power, conductors, signaling and telegraphy and a monthly publication beginning with January, 1899, is to be issued, embracing patents in all these classes, the price of subscription to be $25 per annum.

GASKETS BLOW OUT.—Engineers complain that on account of the inferior quality of gaskets they are experiencing a great deal of trouble with leaking manholes and hand-hole plates. It is not an uncommon thing with engineers who use such gaskets to have them blow out entirely, which in most

cases necessitates the shutting down of the plant and frequently results in personal injury to themselves. The Garlock cut gasket for manhole and handhole are guaranteed to give satisfaction. They are manufactured only by the Garlock Packing Company, Palmyra, N. Y. Prices and catalogues will be mailed on application to the main offices and factories, Palmyra, N. Y., or Rome, Ga., or from any of the company's salesrooms, New York, Boston, Philadephia, Pittsburg, Cleveland, St. Louis and Denver. The Garlock cut gasket is also sold by the leading dealers everywhere.

PAINTING ON METAL.—Messrs. Edward Smith & Co., 45 Broadway, New York, have just brought out a little work which will be appreciated by engineers. It is a scientific treatise on the subject of painting metal to prevent corrosion, together with two sets of specifications, one for best work and the other for ordinary work. In its preparation much of the subject matter was submitted in the manuscript to the criticism of numerous eminent engineers in all parts of the country. The increasing attention which this subject is attracting from engineers and its recognized importance renders this little volume of special value. Its contents represent the result of experience and careful study. Mr. A. H. Sabin is the author of the work, of which a small edition has been printed to be sent only to those who are interested in the subject.

ARC LAMPS AND ACCESSORIES.—The Western Electric Company's Bulletin No. 7002 is devoted to arc lamps and accessories. The bulletin contains full information regarding the different classes and types of arc lamps manufactured by this company, each style of lamp being illustrated. This line of manufacture includes open arc lamps, single carbon arc lamps, single carbon weatherproof lamps; single side-rod lamps; ornamental lamps; short, low ceiling lamps; focusing lamps for street lighting; open arc, constant potential lamps; lamps for stage lighting; inclosed arc lamps; chain-feed lamps; direct carbon feed lamps; switches, hangers, etc. Specifications of each style of lamp are given. On the first page is an illustration of an inclosed long-burning arc lamp of handsome design. It has an egg-shaped globe and reflector, the latter taking the place of the ordinary outer globe.

Directory of Scientific Societies, Associations, Etc., and Meetings of the Same.

HENRY ELECTRICAL SOCIETY meets every other Friday evening in the rooms of the American Institute, New York City, between October and May.

THE NEW YORK ELECTRICAL SOCIETY.—President, Gano S. Dunn; secretary, George H. Guy, 120 Liberty Street, New York.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—F. W. Putnam, secretary, Salem, Mass.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA, Pittsburg, Pa.—Meetings, third Tuesday of each month.

CANADIAN ELECTRICAL ASSOCIATION.—President, William H. Browne, Montreal; secretary, C. H. Mortimer, Toronto, Ont.

CHICAGO ELECTRICAL ASSOCIATION.—Meetings, first and third Friday of each month, from October 1 to June 1; J. R. Cravath, secretary, Monadnock Block, Chicago, Ill.

NORTHWESTERN ELECTRICAL ASSOCIATION.—President, F. A. Copeland, La Crosse, Wis.; secretary, Thomas R. Mercein, Milwaukee, Wis.

MASSACHUSETTS CHARITABLE MECHANIC ASSOCIATION, Boston, Mass.—Exhibition of Motor Carriages, October 10 to December 3, 1898.

STREET RAILWAY ASSOCIATION OF THE STATE OF NEW YORK.—President, G. Tracy Rogers, Binghamton, N. Y. Next meeting, Ithaca, N. Y., September 12 and 13, 1899.

NATIONAL ELECTRIC LIGHT ASSOCIATION.—President, A. M. Young, Waterbury, Conn.; secretary, George F. Porter, 203 Broadway, New York. Next meeting, New York, May or June, 1899.

AMERICAN STREET RAILWAY ASSOCIATION.—President, C. E. Sergeant, Boston, Mass.; secretary, T. C. Penington, 2020 State Street, Chicago, Ill. Next meeting, Chicago, 1899.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.—President, W. W. Ryder, Chicago; secretary, P. W. Drew, Milwaukee, Wis. Next meeting, Wilmington, N. C., June 19, 1899.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, New York.—President, Dr. A. E. Kennelly; secretary, Ralph W. Pope, 26 Cortlandt Street, New York. Meeting, third Wednesday of each month, from September 1 to June 1.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.—President, Samuel Insull, Chicago; secretary, Wilson S. Howell, Harrison, N. J. Last meeting, Sault Ste. Marie, Mich., September 12 and 13, 1898.

THE PACIFIC COAST ELECTRIC TRANSMISSION ASSOCIATION. President, W. F. Pierce; secretary, George P. Low, 427 Tenth Avenue, San Francisco, Cal.

THE OHIO ELECTRIC LIGHT ASSOCIATION.—President, Emil C. Schmidt, Sandusky; secretary and treasurer, Samuel Scovil, care of Cleveland Illuminating Company, Cleveland. Next meeting place, Cleveland, 1899.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION.—Dr. C. R. Dickson, Toronto, Can., president; Dr. John Gerin, Auburn, N. Y., secretary. Last meeting, Buffalo, N. Y., September 13, 14 and 15, 1898.

PENNSYLVANIA STATE STREET RAILWAY ASSOCIATION.—President, Robert E. Wright, Allentown; secretary, S. P. Light, Lebanon. Last meeting, Scranton, Pa., September 7-8, 1898.

ASSOCIATION OF FIRE AND POLICE TELEGRAPH SUPERINTENDENTS AND MUNICIPAL ELECTRICIANS.—President, J. W. Aydon, Wilmington, Del.; secretary, H. T. Blackwell, Jr., New York. Next meeting, Wilmington, Del.

THE SOUTHWESTERN GAS, ELECTRIC AND STREET RAILWAY ASSOCIATION.—President, Carl F. Drake, Austin, Tex; secretary, E. L. Wells, Jr., Marshall, Tex. Next meeting, Austin, Tex., April 19, 1899.

INDEPENDENT TELEPHONE ASSOCIATION OF THE UNITED STATES.—President, Judge James M. Thomas, Chillicothe, Ohio; secretary, W. J. Vesey, Fort Wayne, Ind. Next meeting, June, 1899. Place to be named hereafter.

FRANKLIN INSTITUTE (Electrical Section), Philadelphia, Pa.—Secretary, William H. Wahl. Next meeting September 27. Papers to be read: "Rail Bonding, with Especial Reference to Cast Weld Joints," by W. E. Harrington; "The Present Status of the Storage Battery," by Herbert W. Lloyd.

Business Notice.

THE ILLUSTRATIONS in this issue were made by the Photo-Engraving Company, 9-15 Murray Street, New York City.

UNITED STATES PATENTS ISSUED SEPTEMBER 13, 1898.
[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

610,539. ELECTRIC CLOCK; F. Hopes-Jones and G. B. Bowell, of London, England. App. filed Dec. 18, 1897. The combination of an electrically wound regulator, a secondary clock, the hands of which are moved through the agency of an electric current, means in the regulator for making the electric circuit which operates the secondary clock, and means in the secondary clock for opening said circuit.

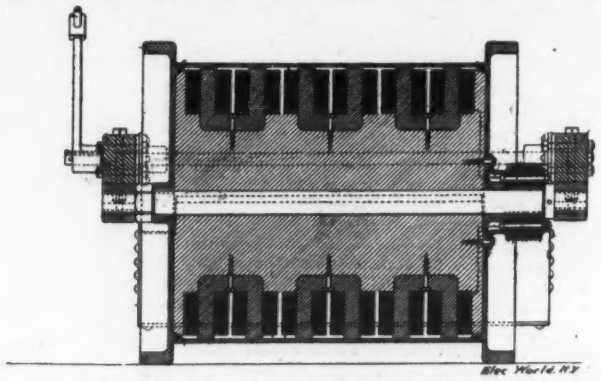
610,620. COMMUTATOR BRUSH HOLDER; W. K. Bassford, Jr., of Bound Brook, N. J. App. filed Feb. 1, 1898. The combination with a commutator of an electric conducting block, a pusher for driving the block against the commutator, and an automatic device for retaining the block from the commutator against the action of the pusher.

610,626. COMPOSITION CONTAINING CASEIN FOR ELECTRIC INSULATING OR OTHER PURPOSES; P. H. Hansen, of Copenhagen, Denmark. App. filed Feb. 7, 1898. A composition consisting of casein, india rubber and asphalt.

610,704. TELEPHONE SYSTEM; W. W. Dean, of St. Louis, Mo. App. filed Sept. 3, 1897. The combination with a telephone circuit of a switch for opening and closing said telephone circuit, means for actuating the same, an electromagnet acting independently of said means, and additional means for maintaining said telephone circuit open, operating independently of said actuating means and controlled by said electromagnet, substantially as described.

610,705. BRUSH FOR ELECTRICAL MACHINES; J. W. Dickey, of New York. App. filed Dec. 8, 1894. A brush for electrical machines, consisting of successive layers of wire gauze formed into the desired shape, and then compacted by pressure.

610,712. APPARATUS FOR STARTING AND CONTROLLING ELECTRIC MOTORS; T. W. Kloman, of New York, N. Y. App. filed April 4, 1898. An electric motor having its field-magnet coil or coils connected permanently in circuit with a main source of current supply, in combination with an independent source of current supply provided with means for connecting it in circuit with the armature of the motor and varying the current relations therethrough, in accordance with the load put upon it, the arrangement being such that the independent source of current supply is never electrically connected with the main source of current supply, substantially as described.



No. 610,767.—Magnetic Separator.

610,767. MAGNETIC SEPARATOR; A. Monell, of Munhall, Pa. App. filed Jan. 10, 1898. A wheeled truck or barrow having a receptacle, a drum arranged to be rotated by the wheels of the truck or barrow, and carrying electromagnets, and switches for said magnets arranged to be actuated by the rotation of the drum.